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# DEVELOPMENT OF PATH GAMING METHODOLOGY

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PATH Gaming is a new research tool which allows one to investigate the possible paths connecting the present day strategic environment with a preferred one in the future. This analysis is conducted within the planning process. This tool helps decision-makers better understand the complex interrelationships among the critical variables which affect the long-term consequences of current decisions.

This report is intended to aid the potential users of path gaming in determining whether this tool is appropriate for their specific application and then in determining the gaming format best suited for their needs. Four path gaming formats are described: mini-games, one-day games, multi-day games, and extended games. A series of guidelines are offered to help choose a gaming format.

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# EXECUTIVE SUMMARY

Games have been used as an aid for decision-makers such as military officers, government officials and business executives for many years. This report will describe a gaming methodology, known as path gaming, which is designed to study the long range implications of present day decisions. They are called "path" games because the set of decisions which transform the current strategic environment into a preferred outcome in the future can be seen as a "path." The general technique used to expose this cause-and-effect relationship is to greatly compress time. During the first move of a path game, the players make choices in the current strategic environment, while in subsequent moves they grapple with the implications of earlier decisions. In this way several years or even decades can be traversed in only a few hours or days.

The main purpose of this report is to aid potential users of path gaming in determining whether this technique would be useful for their specific applications, and then to help them in determining the particular gaming format that is best suited for their individual needs. In a sense, this report serves as a path gaming catalog.

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## INTRODUCTION TO GAMING

Gaming can be used to put a selected group of experts into a structured environment where their collective expertise can be exploited more effectively than is possible in other research techniques. In general terms, a "game" can be defined as follows:

> A **game** is a group of **people interacting** through an agreed set of **rules** in order to achieve a **goal**.

The people are typically organized into teams which represent real organizations, countries, or groups. The interaction occurs through a series of moves during which the players make decisions or perform actions in order to achieve their stated goal. The rules are intended to represent "reality" and are administered by a "control" team. Finally, the goal can range from winning a battle to resolving an international crisis or making decisions on long range planning. A game need not have any "winners" or "losers."

Gaming techniques can be distinguished by the degree to which the rules structure the interaction of the players. A proper balance must be maintained between restrictions which focus the players attention on the specific problem under consideration and freedom which allows the players to investigate creatively all aspects of the problem not considered by the game's developers. This report will concentrate on one variant of gaming which is very unstructured and provides the players with much latitude in interpreting their roles. This technique is most useful when

the main issue is to understand the constraints on a given problem or to illuminate the complexity of the interaction among the key actors.

Gaming can be used for three basic purposes: (1) to educate either a large or small audience of officials at the staff level, mid-level management, or senior level management in the complexities of major issues; (2) to task the players to make recommendations regarding policy changes based on their conclusions from a game or set of games; and (3) to identify all relevant issues related to a given problem, and especially those that might not otherwise be apparent.

## PATH GAMES

Path Gaming is a specific gaming technique which employs an unstructured, free style game to investigate long range planning problems with the main purpose of examining the future implications of present-day decisions by greatly reducing the normal time lag between a decision and its consequences from several years to several hours or days. Its main purpose is not to determine the winner or loser of a conflict, but rather to investigate the decisions which must be made in order to obtain a desired outcome at some point in the future. Since conflicts, as such, are not the main problem being modeled, path games can be played with only one team.

The style of play can be either "closed" or "open," which basically refers to how freely the players on different teams can interact. In closed games not only do the teams meet separately, but also the control team regulates all inter-team communications. In open games, on the other hand, the teams are allowed to interact directly (either verbally or in writing) without the control team restricting the flow of information. Open play is less realistic and makes the game less structured, but since the primary purpose of path gaming is not to model the real world this loss is not serious.

A path game can consist of as few as one team to as many as four. A color coding scheme is used as a short hand for the following convention: (1) a blue team to represent the organization sponsoring the game; (2) a red team to represent the blue team's main competition; (3) a green team to represent the other relevant groups which are not in direct competition with the blue team; and (4) a control team to represent higher level decision-making authorities and to perform routine administrative functions.

For applications in international security, the blue team could be the executive branch of the federal government, the red team could be the Soviet Union, and the green team could be a combination of domestic and foreign groups (including the U.S. Congress, the NATO allies and public

opinion in Europe and the U.S.). Typically the size of each team varies from 10 to 20 players.

Computers can be used to perform various functions during a game. A personal computer linked to an RGB (Red-Green-Blue) projector can be used to display game materials such as the description of the scenario, the charge to the players, or other information required by the players. A computer is also useful in maintaining a record of the proceedings of the game. If the game play is closed, then a computer network at a gaming center can be used to facilitate the inter-team communications. Finally, the calculational speed of a personal computer can, in principle, be used to perform quantitative analyses. The control team or even the players themselves can perform these calculations.

However, two limitations on the use of computers should be noted. First, one should avoid unnecessarily distracting the players' attention away from strategic issues and towards minor details. Second, given the unstructured nature of path gaming, anticipating the precise kinds of calculations that might be required by the players is difficult at best. Therefore in most path gaming formats, computers are used only to display game materials and produce a record of the proceedings.

The character of a path game can change depending on the type of players involved in it. For the purposes of this report, three different kinds of players will be considered:

(1) consultants, or experts from outside of the organization sponsoring the game(s) (e.g., professors from academic institutions or members of consulating firms); (2) staff, or the support personnel and mid-level management working under a senior level decision-maker; and (3) decision-makers, or senior executives who are authorized to make strategic level decisions. Figure 1 summarizes some of the differences caused by the involvement of each type of player in the various path game formats discussed below.

The amount of resources needed to play a path game is a strong function of the length of the game. Gaming formats with long moves make sense only if they involve a large number of players and consequently large gaming facilities. In addition, games with long breaks between moves make extensive use of the control team to perform analysis. Both factors drive up the cost of a game.

The four main formats used in path gaming and their chief attributes are summarized in Figure 2. Each is discussed separately below.

**MINI-GAMES**

The main attribute of a mini-game is its simplicity, but like many simple tools it can be used best only for certain types of applications. The problem addressed in a mini-game should be sufficiently limited in scope for a blue team,

| | Consultant | Staff | Decision-Maker |
|---|---|---|---|
| Mini-Game | Preparation for large path game or series of mini-games | Investigate one large scale move or two short scale moves by staff and contractor in one half day; best in part of series. | Decision-makers involved in one game at end of series played by staff |
| One Day | Not Applicable | More detailed investigation of one or more related paths but with little inter-move analysis | Involvement of decision-makers as team leader to add realism |
| Multi-Day | Not Applicable | Very detailed investigation of one or more related paths with some inter-move analysis by Control | Possible involvement at last day with staff playing first several days |
| Extended | Experimental game to further develop technique (logistics, computer programs, etc.) | Staff-level officials meet for half day every 1-3 weeks for one move; control performs analysis between moves; players discuss options in more detail | Not Applicable |

Figure 1. Matrix of path game types.

| | Mini-Game Format | One Day Game Format | Mult |
|---|---|---|---|
| Purpose | To use a small group of experts to investigate a set of inter-related issues in a structured seminar format. | To involve a large group of officials in a discussion of a major policy issue in order to expose them to new ideas or approaches. | To investigat and expose a l a wide array o |
| Strengths | (1) Identify major issues and actors related to given issue; (2) Create group of experienced players for future use, including educating small groups of senior decision-makers. | (1) Educate large number of people in new issues or approaches with more impact than standard briefings or reports; (2) Identify previously unrecognized issues or problems as a by-product of education. | (1) Educate a extreme1y comp length of ga control tea from game. |
| Weaknesses | (1) Severe time constraints restrict use of inexperienced players; (2) Limited ability to formulate specific policy recommendations. | (1) Use of inexperienced players limits possibilities of tangible outputs such as specific policy recommendations; (2) Need for the facilities of a gaming center increases costs and logistical problems. | (1) Logistical gaming center, resulting pl participants a game, cost, co materials; (2) than with othe |
| Length of Game | 4 hours | 1 day | |
| Move Duration | 1 hour | 2 hours | |
| Inter-Move Duration | None | 1 hour | |
| Number of Moves | Two with replay of first move | Three or two with replay of first move | Three with |
| Game Play | Open | Either open or closed | Eith |
| Number of Teams | 2 (Blue, Control) | 3 - 4 (Blue, Red, Control, Green) | (Blue, |
| Number of Players | 12 - 18 | 40 - 50 | |
| Type of Players | | | |
| Consultant | Participate as outside experts to provide fresh insights or play separate games in preparation of large game or series of mini-games. | Participate as outside experts to provide fresh insights. | Participate a: fresh insight |
| Staff | Investigate one large scale move and several paths or two short scale moves with support from consultants. | More detailed investigation of one or more paths. | Detailed inv paths with the control t |
| Decision-Maker | Several senior level decision-makers involved in one mini-game following a series played by their staff. | Involved as team leaders in order to add realism to game. | Possible inv which would b with benefit |
| Facilities | Seminar room with computer and RGB projector | Gaming center | |
| Support | Minimal: control team is small and needed mainly to monitor discussions during game. | Large: Control team administers all communications and develops new charges for each move. | Large: Cont communicatio each move, a |

Figure 2. Summary of path game formats.

| ...me Format | Multi-Day Game Format | Extended Game Format |
|---|---|---|
| ...roup of officials in ...ajor policy issue in ...hem to new ideas or | To investigate a large, complex problem and expose a large number of officials to a wide array of related issues. | To examine in detail a relatively well-defined problem in order to formulate policy recommendations and educate staff level officials on complexities involved in relevant problem. |
| ...mber of people in new ...es with more impact ...iefings or reports; ...ously unrecognized ...as a by-product of | (1) Educate a large number of people in extremly complex issues; (2) Longer length of game and increased role of control team increases tangible output from game. | (1) Formulate policy recommendations due to increased focus of game and ability to accomodate more data analysis. |
| ...enced players limits ...gible outputs such as ...mmendations; (2) Need ...of a gaming center ...logistical problems. | (1) Logistical problems include: need for gaming center, large time commitment and resulting player turnover as many participants are unable to attend entire game, cost, control over sensitive game materials; (2) Cost-effectiveness is less than with other formats. | (1) Limited utility for education and the need for experienced players; (2) Narrow focus of game limits ability to identify new issues; (3) Logistics are complex and the support from the control team more expensive. |
| ...day | 3 - 4 days | > 1 month |
| ...hours | 4 hours | 4 hours |
| ...hour | 1 day | > 1 week |
| ...replay of first move | Three with possible replay of first move | Three |
| ...en or closed | Either open or closed | Either open or closed |
| ...- 4 (...Control, Green) | 4 (Blue, Red, Control, Green) | 3 (Blue, Red, Control) |
| ...- 50 | 40 - 50 | 30 - 40 |
| ...ide experts to provide | Participate as outside experts to provide fresh insights. | Participate as outside experts to provide fresh insights or play experimental games to further develop the technique. |
| ...estigation of one or | Detailed investigation of one or more paths with some inter-move analysis by the control team. | Investigate specific policy issue and formulate recommendations based on analysis provided by control team. |
| ...aders in order to add | Possible involvement on last day/move which would be a replay of first move with benefit of hindsight. | Unlikely that senior decision-makers would be directly involved, only briefed on results. |
| ...g center | Gaming center | Gaming center |
| ...team administers all ...develops new charges | Large: Control team administers all communication, develops new charges for each move, and performs data analysis. | Extensive: Control team performs much analysis between moves, develops more detailed charges for each move, in addition to administering and scheduling each meeting. |

...ary of path game formats.

supplemented by individual players representing red and green teams, to address all of the major questions.  Within these constraints, a mini-game can bring together a group of knowledgeable officials and outside experts to discuss a set of interrelated issues in the format of a structured seminar. This format is best suited for identifying issues and questions which have not be adequately considered, but must be in order to obtain a preferred future goal.  While going through a simulated decision-making process, the players themselves can become better educated both in the substance of the issues under consideration and in the best means of approaching a problem.

The two main characteristics of a mini-game are the short move duration and minimal inter-move duration.  Moves are approximately one hour long and are played essentially without any break between moves.  These two attributes combine to place severe time constraints on the players.  The discussions must not become sidetracked on irrelevant issues. The style of play is inherently open and all players can freely interact.  Given the short length of the game (i.e., four hours), senior decision-makers can easily participate. However the severe time constraints require that most of the players, and especially the team leaders, be experienced players.  No more than a few new players can be accommodated into this format.

The main strengths and weaknesses of the mini-game
format are summarized in Figure 3.

**ONE-DAY GAME**

The primary objective of a one-day game is to involve a
large group of people in discussing a single major issue for
which they all are responsible.  Many problems that the
Defense Department, other government agencies, and private
industry must deal with are extremely complex with many
interrelated variables.  Many different groups or
organizations may be working on different aspects of the
problem, but without understanding how their efforts affect
each other.  This understanding can be increased by having
key members from each relevant group participate in a path
game.

The main difference between a mini-game and one-day game
is the relaxation of the former's time constraints which
permits the use of several teams and inexperienced players.
A one-day game, as the name implies, takes one full working
day to play.  Each move lasts for one to two hours with a
break of less than one hour between moves.  Thus a game will
consist of approximately three moves.  Because the issues
which are addressed in a one-day game are generally broader
in scope than is the case with mini-games, the scale of each
move is typically longer, e.g. one to five years.

| Purpose | Strength | Weakness |
|---|---|---|
| Education | Expose small group to new issues and gaming methods | Unable to handle more than a few new players |
| Issue Identification | Locate many new features to problems by combining expertise of players | Issue must be small in scope and modeled with one team |
| Policy Recommendation | Suggest broad change in strategies | Limited by inability to include any detailed analysis in game |

Figure 3.   Strengths and weaknesses of mini-game.

Unlike mini-games, one-day games can be played as either open or closed. Note, however, that if play is to be closed then a larger control team may be needed in order for it to regulate all of the inter-team communications. A closed game may also require the use of a formal gaming center which has the facilities to permit the teams to meet individually and an auditorium large enough for plenary sessions.

The main strengths and weaknesses of the one-day game format are summarized in Figure 4.

## MULTI-DAY GAME

The multi-day gaming format is best adapted for the purpose of exposing a large number of people to a very complex and intricate problem. In particular, the issue must be sufficiently complicated for the control team to need more than the short break between moves available to them in the one-day format in order to prepare for each move. In many respects, a multi-day game combines the advantages -- and disadvantages -- of both the one-day and extended games. It allows the players to consider a problem in more detail than is possible in a one-day game, without the time commitment of an extended game. However, at the same time the players must be willing to devote three to four consecutive mornings to the game, an obligation that many busy officials may find difficult to keep.

| Purpose | Strength | Weakness |
|---|---|---|
| Education | Expose large group to new concepts and approaches | May be expensive and require much pre-game analysis |
| Issue Identification | Locate unresolved problems in broad policy questions | Result is indirect outcome from process of education |
| Policy Recommendation | Suggest broad change in strategies | Limited by inability to include any detailed analysis in game |

Figure 4. Strengths and weaknesses of one-day games.

The main attributes of the multi-day game format are: the duration of the moves is four hours, which is much longer than in other formats; and the inter-move duration is one day, with moves being played on consecutive mornings and the control team using the time in between for preparing each move. Given the complexity of the problems for which this format is designed, typically four teams (including the control team) are included. A game lasts for three or four moves and the last move is usually a re-play of the first move when the players are encouraged to reconsider their initial decisions in light of the outcome of the previously played moves.

The main strengths and weaknesses of the multi-day game format are summarized in Figure 5.

**EXTENDED GAMES**

Extended path games are used primarily for the detailed examination of a well-defined problem, or path, by a group of staff level officials, mid level managers, and outside consultants. In addition to carrying out basic research into policy options, these games can be used to educate some of the players in the complexities of an issue or to change their perspective from immediate, short-term problems to strategic issues and the long term implications of current decisions. This format is best suited for issues which required extensive amounts of data analysis.

| Purpose | Strength | Weakness |
|---|---|---|
| Education | Expose large group to issues related to very complex issue | Extremely expensive to play game, large time commitment |
| Issue Identification | Locate unresolved problems in broad, long range policy questions | Poor cost-effectiveness due to expense and player turnover |
| Policy Recommendation | Suggest more detailed changes in strategy | Poor cost-effectiveness due to expense and player turnover |

Figure 5.   Strengths and weaknesses of multi-day games.

The most important attribute of an extended game is the use of the extremely long breaks between moves by the control team for analysis. These breaks vary from one week to three weeks, depending on how much time the control team requires and the scheduling problems involved in organizing each move. The moves themselves typically last for a half day, or four hours, and a game consists of three moves.

A low player turnover is an essential aspect of this format because a considerable amount of effort will be expended on bringing the players into strategic mind-set of the game. They must be familiar with the previous moves, accept the changes produced in the strategic environment of the game, and act as if they were in it (e.g., they must be able to play the game as if they were 5 to 10 years into the future). If new players were introduced constantly into the game then this essential continuity would be disrupted and the control team would have to spend much of each meeting on briefing the new players.

The main strengths and weaknesses of the extended game format are summarized in Figure 6.

## METHOD OF SELECTING GAMING FORMATS

The most important inputs which determine the most appropriate gaming format for a given application are: the purpose of the game itself, the type of topic being addressed (which could be either narrow and well-focused or broad and

| Purpose | Strength | Weakness |
| --- | --- | --- |
| Education | Expose small group to issues related to very complex issue | Extremely expensive to play game, time commitment too large |
| Issue Identification | Possibly locate obstacles to implementing policy recommendations | Format too structured to permit wide-ranging discussions |
| Policy Recommendation | Detailed analysis in game permits players to make good policy recommendations | Players may not use inter-move breaks effectively |

Figure 6. Strengths and weaknesses of extended games.

ill-defined), and the level of resources available for the game (including the total amount of time to be used in the study).

Before actually deciding on the gaming format to be used in a given application, it is essential that the game's sponsors and developers consider several important trade-offs. No one format will maximize all parameters. Three trade-offs are: the relative priorities attached to each purpose for the game (e.g., education of the players, identification of issues, and formulation of recommendations), the continuity of play as measured by the length of the breaks between moves, and finally the problem of cost-effectiveness.

The problem of selecting the most appropriate gaming format is a difficult one. No hard, rigid rules for determining the best format for a given application exist. Some general guidelines are offered in Figures 7 through 9 in order to aid the developers and sponsors of path games in matching their needs to a reasonable gaming format. These recommendations are grouped according to the inputs discussed in above. In each chart the suggested format is highlighted.

| | Education | Specific Recommendation | Issue Identification |
|---|---|---|---|
| **Mini–Game** | Good for small group of players | Possible | *Very Good* |
| **One–Day Game** | *Very Good* | Unlikely | Possible |
| **Multi–Day Game** | Good | Possible | Possible |
| **Extended Game** | Good for small group of players | *Good* | Unlikely |

Figure 7. Recommended gaming format depending on purpose.

| | Broad Ill Defined | Narrow Well Focused |
|---|---|---|
| Mini-Game | *Very Good* | Good |
| One-Day Game | *Very Good* | Good |
| Multi-Day Game | Good | Good |
| Extended Game | Poor | *Very Good* |

Figure 8. Recommended gaming format depending on game topic.

|                  | Short<br>($< 3$ mo.) | Medium<br>(6 mo. – 1 yr.) | Long<br>($> 1$ yr.) |
|------------------|----------------------|---------------------------|---------------------|
| Mini–Game        | *Good*               | *Very Good*               | *Very Good*         |
| One–Day Game     | Possible             | *Good*                    | *Very Good*         |
| Multi–Day Game   | Poor                 | Possible                  | *Very Good*         |
| Extended Game    | Poor                 | Possible                  | *Very Good*         |

Figure 9.  Recommended gaming format depending on period of performance.

PREFACE

This report is based upon research conducted jointly for the Defense Nuclear Agency and the Strategic Defense Initiative Office under contract DNA001-85-C-0247 by Harold Rosenbaum Associates, Inc. The subcontractors for this effort were GAMA Corporation and Science Applications International Corporation. The purpose of this contract was to develop and improve the methodologies of path gaming and apply them to general problems related to the Strategic Defense Initiative. This final report covers only the methodological aspects of this research.

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# SECTION 1

## INTRODUCTION

Games have been used as an aid for decision-makers such as military officers, government officials and business executives for many years. Most of the problems dealt with in these games have involved relatively short time scales: battles or international crises. This report describes a gaming methodology, known as path gaming, which is designed to study the long range implications of present day decisions. They are called "path" games because the set of decisions which transform the current strategic environment to a preferred outcome in the future can be seen as a "path." The general technique used to expose the cause-and-effect relationship between decisions made today and their consequences in the future is to greatly compress time. During the first move of a path game, the players make choices in the current strategic environment, while in subsequent moves they grapple with the implications of earlier decisions. In this way several years or even decades can be traversed in only a few hours or days.

Path gaming has been applied to general problems in national security, arms control, and military strategy. These uses will be discussed in this report. However, it should be noted that path gaming can also be applied to

similar issues (i.e., those involving long range planning) in business and domestic politics.

The main purpose of this report is to aid potential users of path gaming in determining whether this technique would be useful for their specific applications, and then to help them in determining the particular gaming format that is best suited for their individual needs. In a sense, this report serves as a path gaming catalog.

In general, a path game can serve three basic purposes. First, it can be used to educate managers and their staff in the complexities of broad, strategic issues and in novel approaches to existing problems, or to expose them to a wide variety of opinions and perspectives. Second, it can be used as a decision aide by helping officials in identifying key issues that will require their attention -- issues that might not be recognized using more traditional methods. Finally, path gaming can be used more directly to help formulate policy recommendations.

The next section opens with a general problem that can be studied using path gaming, namely, the issue of modernizing NATO's conventional forces. This example is used throughout the report in order to illustrate various applications of the techniques discussed in each section. The intent of this chapter is to describe simulation techniques, including path gaming, and to identify those

applications where path gaming could prove to be a valuable research tool.

Section 3 describes path gaming and its main characteristics in detail. It defines and discusses the terminology used in this report. For the reader's convenience, a glossary of gaming terms is also provided in an appendix at the end of the report. The next four sections are each devoted to a detailed description of the primary gaming formats used in path gaming: (1) mini-games which last only four hours and involve approximately a dozen players; (2) one-day games which can include several teams and as many as 50 players; (3) multi-day games where each move is played in the morning of several consecutive days; and (4) extended games where consecutive moves are separated by one or more weeks, allowing detailed analysis to be performed between moves. Each chapter includes a discussion on the purpose of the format, a description of its main attributes, and an evaluation of its strengths and weaknesses.

The final section provides some general guidelines on selecting the most appropriate gaming format given the purpose of the game, the type of problem being addressed, and the level of resources available. These recommendations are summarized in a series of matrices.

Several appendices are also included: (A) a glossary of gaming terms, (B) a summary of all of the charts and figures used in the report, (C) a short overview of some recent path

games in the general area of national security, (D) a

handbook for the development of "Computer-Aided Decision

Simulations," which are also referred to as mini-games in

this report; and (E) a description and evaluation of a

computer program that could be used as a decision tool to

help players in a path game.  This computer program is based

on "multiple attribute decision theory" which allows the

analysts on the control team (which monitors and regulates

the play in a game) to assign an overall "figure of merit" to

the outcome of each move, as determined by the players and

interpreted by the control team.

# SECTION 2

## INTRODUCTION TO GAMING

On December 8, 1987 President Ronald Reagan and General Secretary Mikhail Gorbachev signed the Treaty on the Elimination of Intermediate-Range and Shorter-Range Ballistic Missiles. At the same time, however, this treaty dramatically alters the nature of the military balance in central Europe by accentuating the role of the conventional armed forces of NATO and the Warsaw Pact. In the wake of the INF Treaty and with the prospect of deep reductions in the strategic nuclear forces of the two superpowers, the modernization of NATO's conventional forces has once again become a major issue confronting the alliance. This problem, like so many others in the area of international security, is not purely a military-technical question. It is not, for example, merely a matter of determining the most cost-effective means of neutralizing the Warsaw Pact's tremendous advantage in main battle tanks. A whole range of political, economic, as well as military and technical factors affect the ability of NATO to upgrade its capability to conduct conventional operations.

A key aspect of this problem that is frequently either omitted or underestimated is the impact of the dynamic interaction of the various actors involved in the actual

decision-making process.  This interaction can take the form
of cooperation, competition, or a mixture of the two.

Traditional systems analysis entirely ignores such
problems as European resistance to deploying advanced
conventional weapons simply because they were made by
American companies, and not European ones.  Strategic
analysis, while avoiding the emphasis on the quantitative
measures of effectiveness used in systems analysis, has a
tendency to assume the decision-making process is overly
rational and focused.  Neither of this qualities adequately
describe a real decision-making process because seemingly
irrelevant factors can and do affect decisions on national
security.  For instance, the American public's resentment
towards foreign competition greatly exacerbates the issue of
"burden sharing"  in NATO.  Historical analysis, on the other
hand, can provide a broader perspective for problems of
current interest, but only within the limits historical
analogy.  The problems associated with the Lisbon goals of
1952 furnish some interesting insights into contemporary
problems, but the strategic environment of 1988 is radically
different from that of 1952, a fact which severely restricts
the utility of historical analysis.

The dynamics of the decision-making environment directly
involves the interaction of people, and most traditional
research methods do not adequately model this problem.
Gaming techniques, which have been applied to the study of

international crises and wars, can be used to investigate
many long-range planning problems in the area of interna-
tional security.  This report will discuss several variants
of a gaming technique known as "path gaming," where a "path"
is defined as a set of strategic level decisions which
connect the current strategic environment to a preferred one
in the future.  The decisions which must be made in order to
move from the current imbalance in conventional forces in
central Europe to a more stable balance at lower force levels
is one example of a path.  A key attribute of a Path game is
that it decreases the time between when a decision is made
and when its consequences are felt.  In this way it is easier
to understand the long range impact of present day decisions.

As the example of NATO conventional force modernization
suggests, gaming techniques could be a useful means of
understanding of wide range of problems: the impact of US
domestic politics on the ability to create and sustain a
consensus supporting the modernization programs; the role of
inter-service rivalries and joint programs in exploiting the
new "emerging technologies" in more cost-effective manners;
the effect of the relations between the US and the European
allies in a wide array of issues, from purely military
problems to political issues and even trade and economic
disputes; and the impact of Gorbachev's "new thinking" on
public's perceptions of the Soviet threat.

## 2.1 DEFINITION OF GAMING.

Gaming can be used to put a selected group of experts into a structured environment where their collective expertise can be exploited more effectively than is possible in other research techniques. In order to describe the utility of gaming techniques, a general definition of a "game" must be provided:

A **game** is a group of **people interacting** through an agreed set of **rules** in order to achieve a **goal**.

The four key terms are: "people," "interacting," "rules," and "goal." The people (or players) are typically organized into teams which represent real organizations, countries, or groups (e.g., the National Security Council, West Germany, or the American public). The interaction, which can take the form of cooperation or competition, occurs through a series of moves during which the players make decisions or perform actions in order to achieve their stated goal. The rules which govern the interactions among the players can be either very specific or purposely left vague. In either case, the rules are intended to represent "reality" and are administered by a "control" team.* Finally, the goal can range from winning a battle to resolving an international crisis or making decisions on long range planning. A game need not have any "winners" or "losers."

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*The glossary at the end of this report contains brief definitions and descriptions of the terms used in gaming.

In fact, gaming is just *one* form of simulation method. Others methods include stochastic simulations, mathematical models, and physical models. Stochastic simulations assume that randomness plays an important part in the problem under investigation, and usually rely on computers to perform many repetitive calculations. Both man-machine and machine-machine simulations can be used. A simple example of the former is a video arcade game, and a common illustration of the latter is a strategic force exchange model. Man-machine simulations model the interaction of man with either nature or a formalized opponent.

Mathematical models can be grouped into two broad categories: analytical models and game theory.* Analytical models represent real systems by means of a set of equations. An example is the Lanchester model of combat:

$$\frac{dR}{dt} = - b \, B \qquad \text{and} \qquad \frac{dB}{dt} = - r \, R, \qquad (1)$$

where R is the number of "red" troops at a given time t and r is a measure of their combat effectiveness (e.g., their rate of fire times the probability that they will hit a "blue" soldier), and B is the number of "blue" troops and b their

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*It should be noted that "game theory," as this is commonly used, is **not** the theory behind the kinds of games discussed in this report. It is a highly formalized representation of conflict which relies on linear programming. The theory behind the gaming techniques covered in this report could be called the "theory of gaming."

combat effectiveness. These two equations then model the attrition of both sides during the course of a battle.

Game theory models quantitatively the choices which people in a conflict situation must make. A simple model is shown in Figure 10 where a "red" force chooses between one of two points to attack "blue's" defenses, and the "blue" force can reinforce his defenses at either point. The result is a simple two-by-two matrix where the entries are the probability that red's attack will succeed. Game theory can then be used to calculate where red should attack and where blue should defend in order for blue to minimize red's chances of success, and for red to maximize his chances of success.

Physical simulations involve the use of scaled models of a real system. While commonly used in the natural sciences and engineering (e.g., the use of model airplanes in wind tunnels), the military also makes extensive use of physical simulations in the form of military exercises such as the annual REFORGER exercises in Europe. The main purposes of such field exercises are to train the troops to perform their assigned tasks quickly and efficiently and to test the validity of current tactics.

In these examples the rules of interaction are well defined and known, and the goals are very specific. This is not always the case. In general, if the problem can be well characterized by the rules and a clearly defined goal, then

Blue's Choices

| Red's Choices | Reinforce Defense in Region 1 | Reinforce Defense in Region 2 |
|---|---|---|
| Concentrate Attack in Region 1 | 0.5* | 0.8 |
| Concentrate Attack in Region 2 | 0.6 | 0.2 |

*Probability Red attack succeeds.

## Game Theoretic Solution:

1. Red should attack region 1 4/7 of the time, and in region 2 3/7 of the time.
2. Blue should defend region 1 6/7 of the time, and in region 2 1/7 of the time.
3. Red's expected probability of success is 0.543.

Figure 10. Example of game theory model.

the basis may exist for more quantitative analysis using the techniques noted above. On the other hand, if the dominant part of the problem under investigation relates to the competition among the major actors, then gaming will prove to be a valuable research tool.

Gaming techniques can be distinguished by the degree to which the game's rules structure the interaction of the players.* A proper balance must be maintained between restrictions which focus the players attention on the specific problem under consideration and freedom which allows the players to investigate creatively all aspects of the problem not considered by the game's developers. One variant of gaming is very unstructured and provides the players with much latitude in interpreting their roles. This technique is most useful when the main issue is to understand the constraints on a given problem or to illuminate the complexity of the interaction among the key actors. In the example of NATO's conventional force modernization, this free-style gaming could be used to investigate the political problems in coordinating the programs of the major NATO allies in joint ventures to produce advanced weapons. A second variant is more controlled and is designed to solve a well-defined problem. In this case the players have significantly less freedom in re-interpreting the main

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*For a discussion of general gaming techniques, see Clark C. Abt. Serious Games. (New York: Viking Press, 1970): pp. 89-102.

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issues, and the rules are more specific in governing the game's play. An example would be a game where a group of military officers from NATO countries use a postulated conventional force structure and existing NATO military doctrine to plan and organize a defense against a given Warsaw Pact attack. The purpose of this game would be to assess the effectiveness of a proposed modernization program. A third variant is a highly structured game where the players are given little leeway to reinterpret the assumptions behind the game's scenario. The main function of the game is to train the players to perform specific tasks or to behave in certain ways under given conditions. Military training exercises are the most common example of this variety of game.

These techniques can be applied to three general problems in the area of international security. War gaming is perhaps the best known application due in large part to its long history. Since the end of World War II and especially with the large scale deployment of nuclear weapons, another application has become more prevalent, namely crisis gaming. In this case, a military engagement is not modeled, but rather the incidents leading up to a possible war are studied with the intent of avoiding an actual conflict. A third application, which forms the main topic of this report, emphasizes the long range planning process, including both the development of strategic policies and forces.

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Gaming can be used for three basic purposes: (1) education, (2) formulation of policy recommendations, and (3) identification of key issues. Although all types of games can be used for a variety of objectives, each is best suited for a particular purpose. One of the main functions of this book is to aid the reader in determining the specific gaming techniques that is best suited for his or her particular interests.

Games are used to educate either a large or small audience of officials at the staff level, mid-level management, or senior level management. For example, a game can use a group of experts who are experienced in gaming techniques to expose a small number of senior decision-makers to a wide variety of view points and encourage them to examine strategic issues in novel ways. The purpose of education could be to present game players with (1) issues and opinions to which they do not routinely come into contact, (2) particular problems which require their attention but for which more traditional research methods are inappropriate, or (3) new modes of thinking (e.g., to encourage them to change from thinking primarily about short-term, day-to-day problems to devoting more consideration to long range, strategic issues). A gaming exercise can have a significantly greater impact than more standard briefings or written analyses.

Alternatively, the purpose of the game could be more tangible: players could be tasked to make recommendations

rejarding policy changes based on their conclusions from a
game or set of games.  These recommendations could be in the
f rm of changes in broad policies or specific changes in
p rticular programs, depending on scope of problem studied in
the game.

The purpose could also be to identify all relevant
issues related to a given problem, and especially those that
might not otherwise be apparent.  This could involve iden-
tifying interrelationships among seemingly unrelated issues
or events which have an impact on the decision-making
environment.  A game can locate organizations or individuals
which are not adequately involved in a decision-making
process.


2.2  PATH GAMING.

Path gaming is a specific gaming technique which employs
an unstructured, free style game to investigate long range
planning problems with the main purpose of examining the
future implications of present-day decisions by greatly
reducing the normal time lag between a decision and its
consequences from several years to several hours or days.
Their main purpose is not to determine the winner or loser of
a conflict, but rather to investigate the decisions which
must be made in order to obtain a desired outcome at some
point in the future.  These sets of decisions are referred to
as "paths" because they appear as roads in a diagrams, such

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as the one shown in Figure 11, which is a schematic
representation of several sets of decisions (paths) related
to the example discussed above. Like other forms of gaming,
the players may be organized into teams representing, for
instance, the U.S., NATO, or the Soviet Union. However,
since conflicts as such are not the main problem being
modeled, path games can be played with only a "blue" team and
a control team.

The problems involved in long range planning are
qualitatively different from those encountered in resolving
international crises or waging war, and consequently path
gaming differs from both crisis and war gaming. Since path
games deal with long range planning, a game can cover as much
as several decades; in contrast, crisis and war games are
usually confined to much shorter periods of time (i.e., days
or weeks). This considerably broader scope means that many
more actors and institutions become involved and a much wider
array of issues must be considered. Because of this com-
plexity, the only form of path gaming that is feasible
involves an unstructured, free style which depends heavily on
the expertise of the players and the skill of the control
team. The more formalized styles which can be used in war
gaming are inappropriate. Path gaming is concerned more with
the strategic decisions which government officials must make,
and which have major implications over the long term, than
with the extraordinary decisions made under the extreme
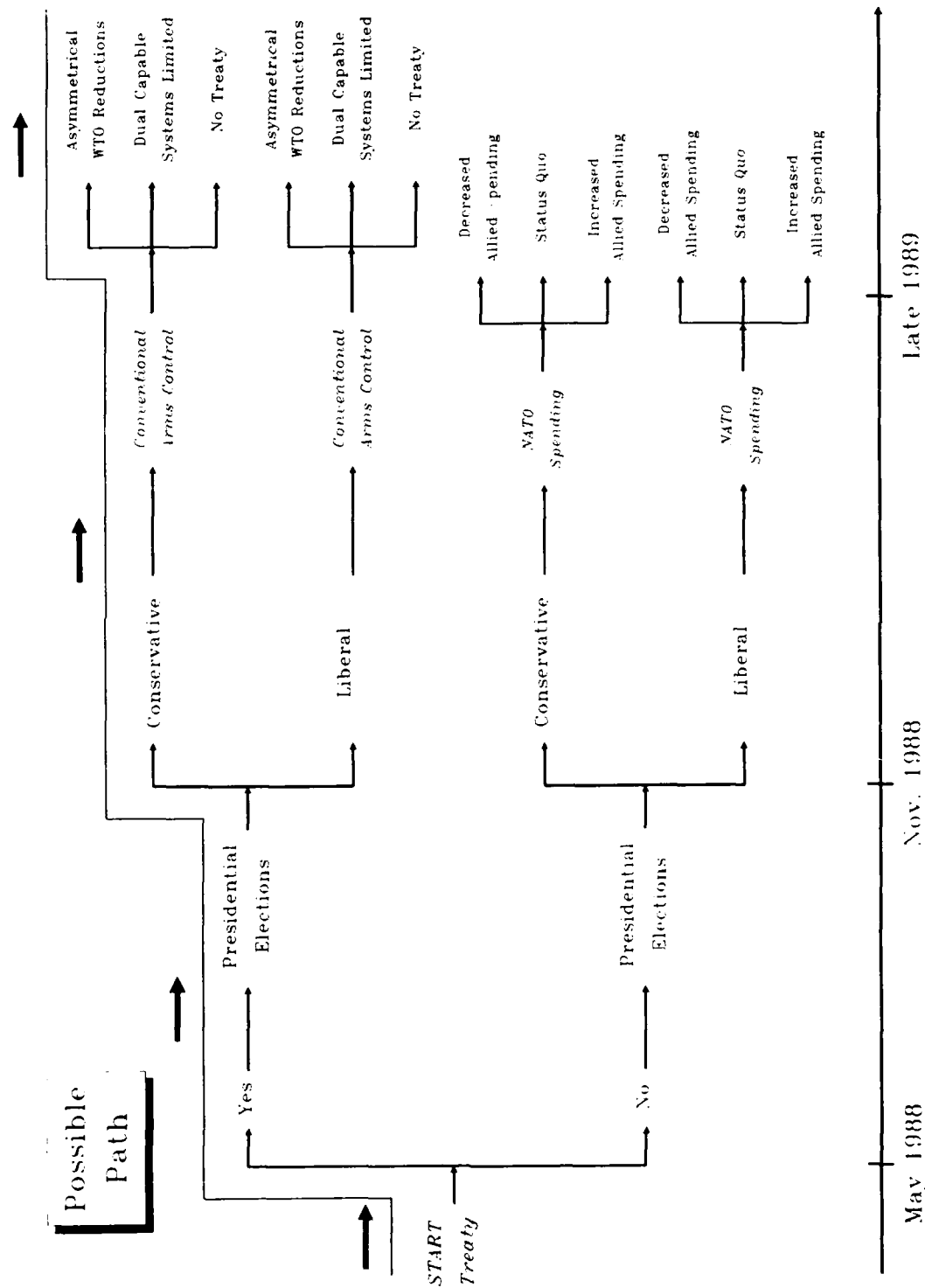
Figure 11.  Path diagram of conventional force modernization.

pressures of a crisis or war.  Unlike crisis or war game, players feel no sense of pressure or urgency.

Consequently a key problem in path gaming, which is less relevant in crisis or war gaming, is the large difference in "real time" (the actual time which the players have to play the game) and "game time" (the fictitious time used in the game for how much time each move covers).  In other words, a move in a path game may cover several years of game time while the players have only several hours of real time during which to make their moves.  Several formats have been developed to resolve this problem.  In a mini-game format a small group of players are brought together for approximately one-half day, and each move lasts one hour.  A second format is a one-day game where a larger group of players are organized into several teams and moves last several hours with a one hour break between moves.  In a multi-day game the moves last one half day (e.g., an entire morning) and occur on consecutive days; the breaks between moves are used by the control team to prepare for the next move.  A final variant is the extended game where moves are separated by one or more weeks, allowing the control team sufficient time for detailed analysis of each move.  The main characteristics, purposes, strengths, and weaknesses of each format are discussed below in Sections 4 through 7.

The first step in the development of a path game is the creation of a "path diagram" (see Figure 11 above for an

example) in which the game's developers outline the major decision points (shown in italics in Figure 11) and the most likely options at each. This diagram is only a rough "road map" to guide the game's developers and the players; it is meant primarily to focus attention on the key issues, not to constrain the game to a rigid scenario. The players can, and should, suggest additional options and decision points during the course of the game. In addition to the decision points where the players actively determine the paths to be followed, there are also points where other variables can strongly influence the course of events. Here the control team determines the path. For example, Figure 11 also includes the effects of the 1988 Presidential elections because the overall viewpoint of the new President on matters of national security will have a clear impact on the decisions to be made subsequently.

Before proceeding to discuss the next steps in the development of a path game, it is worthwhile to consider in more detail the example shown in Figure 11. The first major decision point in this diagram involves a strategic arms control agreement (START). Although not directly impacting the problem of conventional force modernization, a START agreement will affect the general tone of U.S.-Soviet relations and thus the prospects for further arms control agreements. If a START agreement is signed, then, depending on the type of President elected in 1988, it is possible that

a treaty on conventional arms could be signed. This treaty could call for asymmetrical cuts in Warsaw Pact forces as favored by NATO or limitations on dual capable systems (i.e., aircraft, missiles and artillery which can use either nuclear or conventional weaponry) as favored by the Soviet Union. A third possibility, clearly, is that no agreement could be reached. In the absence of a START treaty, the key issue is more likely to be the need to redress the imbalance in conventional forces by increased defense spending by NATO. As noted in Figure 11, there are three obvious alternatives: increased spending, the status quo, or decreased spending. The players in a path game could be asked to investigate under what conditions the NATO allies might agree to increase their defense spending.

The path diagram is then used to develop the specific scenario which is to be presented to the players and to identify the key institutional actors which should be represented in the game. In many ways, this second point is more important given the unstructured nature of a path game. A path game is basically a format for a discussion among knowledgeable people, and thus the kind of experts participating in the game will largely determine its utility. Furthermore, the specific individuals who are to play should be chosen with care. In general, it is wise not to ask for a representative from a key organization to represent them in a game because the players must not only be knowledgeable with

the role they are to play, but also be familiar with gaming techniques. It is especially important that team leaders be either experienced players or thoroughly briefed on path gaming and the scenario under investigation. The team leaders must insure that all players are actively involved in the game and that the points of view of each organization represented in the game is considered.

The actual path game itself begins with the control team presenting the charge to the players, or the specific issues and questions that each player is expected to address during the course of the game. Frequently the players will be considering the same set of questions. A typical path game will consist of two moves where the players investigate the issues surrounding two decision points. A final move can be a replay of the first move where the players can reconsider their initial decisions with the benefit of the insights gained during the game, or it can be a general discussion of the relevant issues uncovered by the players.

Finally, the game's developers analyze the outcome of the game both in terms of the main conclusions related to the game's topic and the methodological issues raised during the organization and execution of the game. In many cases, the results from one game can be used as inputs into a series of games which study a set of interrelated paths, such as those shown in Figure 11 above. Since frequently senior decision-makers were involved in the game (often as team leaders)

post-game briefings are not always necessary.  At the same time, complete documentation of the game is important for use in the development of future games.  Computers can be used for recording and displaying the discussions during the game and subsequently for providing a permanent record.

In addition to the example discussed above, path gaming can be applied to any problem involving long range planning. For the Department of Defense, these can include the impact of current decisions regarding research and development programs or budgets on long range strategic goals or the interrelationships among such major variables as the concerns of the Congress and of U.S. allies, the current administration's foreign policy goals, the constraints imposed by arms control agreements, and inter-service rivalries and the coordinating role of the Joint Chiefs of Staff.  When applied to the broader problems of foreign policy, path gaming can be used to investigate the connections between domestic politics and *foreign policy and the impact of public opinion.*  It can also help avoid approaching regional issues without recognizing the unintended consequences of U.S. policies in one area of the world elsewhere.  In business and industry, path gaming, because it "compresses time" and forces players to address the long range impact of current decisions, can be used to expand the time horizon of management towards longer range issues.  Local politics could also employ path gaming techniques to sensitize local officials to issues outside of

their normal jurisdiction. One such example is transportation planning in the northeastern U.S. where federal, state, and local officials must consider a wide array of economic and political variables which can influence their decisions.*

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*See Abt, <u>Serious Games</u>, pp. 91-94 for a discussion of this example.

# SECTION 3

## MAIN CHARACTERISTICS OF PATH GAMES

Path games can be played in different formats depending on the intended purpose of the game and the resources available for supporting it. The formats vary from "mini-games" which last approximately one morning or afternoon to "extended games" which can last for more than one month, although the game is not played continuously for the entire period. This chapter will briefly summarize four path gaming formats and then define and discuss the main characteristics which distinguish them. Subsequent chapters will describe each format and their strengths and weaknesses in considerable detail.

A mini-game is a path gaming format which entails the least commitment of resources, and thus in many circumstances can prove to be the most cost-effective format. A small group of players (typically between 12 and 18 people) are brought together with a control team of 3 to 4 people to discuss an issue. Since the game lasts for only one half day (4 hours), the questions addressed by the players cannot involve any amount of quantitative analysis. However, if the players are knowledgeable and a sufficient number are experienced in path gaming, then this format is an excellent means of identifying key issues related to the game's topic which have not been considered previously. Frequently simply

recognizing relevant issues alone will justify the time and expense of a path game. A second benefit of a mini-game is the education of a small number of officials through their participation in one or more games either in a broad range of subjects or in novel approaches to old problems.

A second variant is one-day game. In this case, a larger group of participants are involved (from 40 to 50 players), and a formal gaming center is often required in order to support the multi-team structure of the game. While a mini-game is organized around a single team, a one-day game includes from three to four teams, one of which is the control team. The teams can represent, for example, the current U.S. administration (blue team), the Soviet Union (red team), and other related concerns such as the U.S. Congress or public opinion or the NATO allies (green team). The game lasts for one entire day, and the durations of each move being approximately one hour with a short break between them. The main purpose of this format is the education of the various players in issues which are outside of their normal areas of responsibility. Since many of the players are inexperienced in gaming techniques, the control team is more active in this format than in the mini-game format. This is especially true if the play is to be "closed," i.e., if the teams are kept apart with all communication occurring only through the control team.

A multi-day game is basically an expanded version of the one-day game in order to allow more complex issues to be addressed and to provide the control team more time between moves for analysis. This format significantly relaxes the time constraints imposed on the players and the control team in the previous formats. However, the longer length of the game also increases its costs and decreases the chances that players will be able or willing to attend the entire game. The multi-day game format can be used for education, but with more time it can also be used for identifying key issues or formulating policy recommendations, although it may not be cost-effective for the latter purpose. In order for this format to be productive, the control team must be very active and large enough to perform the required analyses and regulate play. Rather than the three members used in a mini-game format, a multi-day game requires a control team of a dozen or more people.

The final format is called an "extended game" because the break between moves (or the inter-move duration) is stretched from one day (for a multi-day game) to one or more weeks. This long break allows the control team more time for data analysis and the preparation of more detailed charges to the players at the beginning of each move. The players also have more time to digest the game material fully and time to consult with their colleagues on the issues raised during the game. The main purpose of this game is to allow the players

more access to quantitative data and to consider a more

specific question in great detail. An extended game is

intended to have the "feel" of the more structured war or

crisis games. Consequently, this format is best suited for

formulating concrete recommendations or determining the

consequences of proposed policies. For these goals to be

accomplished, the control team must be able to provide

extensive support in terms of both running the games

themselves and performing the necessary computations.

The main characteristics of these four formats are given

in Figure 12 below. Before discussing in detail each path

gaming format, the characteristics listed in Figure 12 will

be defined and discussed in the sections that follow. The

first section will cover the attributes related to the gaming

techniques used in each format, while the second section will

discuss the issues surrounding the choice of the participants

in a path game. Finally, some consideration will be given to

the question of level of effort involved in these gaming

formats.


## 3.1 GAMING TECHNIQUES.

It should be recalled that the definition of a game is a

group of people interacting through a set of rules in order

to achieve a stated goal. When applied to path games, the

goal is the three purposes discussed in section 2.2 above:

(1) education, (2) identification of key issues, and

|  | Mini-Game Format | One Day Game Format | M |
|---|---|---|---|
| Purpose | To use a small group of experts to investigate a set of inter-related issues in a structured seminar format. | To involve a large group of officials in a discussion of a major policy issue in order to expose them to new ideas or approaches. | To investi and expose a wide arra |
| Strengths | (1) Identify major issues and actors related to given issue; (2) Create group of experienced players for future use, including educating small groups of senior decision-makers. | (1) Educate large number of people in new issues or approaches with more impact than standard briefings or reports; (2) Identify previously unrecognized issues or problems as a by-product of education. | (1) Educate extremely c length of control te from game. |
| Weaknesses | (1) Severe time constraints restrict use of inexperienced players; (2) Limited ability to formulate specific policy recommendations. | (1) Use of inexperienced players limits possibilities of tangible outputs such as specific policy recommendations; (2) Need for the facilities of a gaming center increases costs and logistical problems. | (1) Logisti gaming cen resulting participant game, cost, materials; than with |
| Length of Game | 4 hours | 1 day |  |
| Move Duration | 1 hour | 2 hours |  |
| Inter-Move Duration | None | 1 hour |  |
| Number of Moves | Two with replay of first move | Three or two with replay of first move | Three w |
| Game Play | Open | Either open or closed | |
| Number of Teams | 2<br>(Blue, Control) | 3 - 4<br>(Blue, Red, Control, Green) | (Bl |
| Number of Players | 12 - 18 | 40 - 50 |  |
| Type of Players |  |  |  |
| Consultant | Participate as outside experts to provide fresh insights or play separate games in preparation of large game or series of mini-games. | Participate as outside experts to provide fresh insights. | Participat fresh insi |
| Staff | Investigate one large scale move and several paths or two short scale moves with support from consultants. | More detailed investigation of one or more paths. | Detailed paths wi the contr |
| Decision-Maker | Several senior level decision-makers involved in one mini-game following a series played by their staff. | Involved as team leaders in order to add realism to game. | Possible which wou with bene |
| Facilities | Seminar room with computer and RGB projector | Gaming center |  |
| Support | Minimal: control team is small and needed mainly to monitor discussions during game. | Large: Control team administers all communications and develops new charges for each move. | Large: C communica each move |

Figure 12.   Summary of path game form

| Game Format | Multi-Day Game Format | Extended Game Format |
|---|---|---|
| group of officials in major policy issue in them to new ideas or | To investigate a large, complex problem and expose a large number of officials to a wide array of related issues. | To examine in detail a relatively well-defined problem in order to formulate policy recommendations and educate staff level officials on complexities involved in relevant problem. |
| number of people in new aches with more impact briefings or reports; reviously unrecognized as as a by-product of | (1) Educate a large number of people in extremely complex issues; (2) Longer length of game and increased role of control team increases tangible output from game. | (1) Formulate policy recommendations due to increased focus of game and ability to accommodate more data analysis. |
| erienced players limits tangible outputs such as recommendations; (2) Need ies of a gaming center and logistical problems. | (1) Logistical problems include: need for gaming center, large time commitment and resulting player turnover as many participants are unable to attend entire game, cost, control over sensitive game materials; (2) Cost-effectiveness is less than with other formats. | (1) Limited utility for education and the need for experienced players; (2) Narrow focus of game limits ability to identify new issues; (3) Logistics are complex and the support from the control team more expensive. |
| 1 day | 3 - 4 days | > 1 month |
| 2 hours | 4 hours | 4 hours |
| 1 hour | 1 day | > 1 week |
| h replay of first move | Three with possible replay of first move | Three |
| open or closed | Either open or closed | Either open or closed |
| 3 - 4 d, Control, Green) | 4 (Blue, Red, Control, Green) | 3 (Blue, Red, Control) |
| 40 - 50 | 40 - 50 | 30 - 40 |
| utside experts to provide | Participate as outside experts to provide fresh insights. | Participate as outside experts to provide fresh insights or play experimental games to further develop the technique. |
| investigation of one or | Detailed investigation of one or more paths with some inter-move analysis by the control team. | Investigate specific policy issue and formulate recommendations based on analysis provided by control team. |
| leaders in order to add | Possible involvement on last day/move which would be a replay of first move with benefit of hindsight. | Unlikely that senior decision-makers would be directly involved, only briefed on results. |
| ing center | Gaming center | Gaming center |
| team administers all and develops new charges | Large: Control team administers all communication, develops new charges for each move, and performs data analysis. | Extensive: Control team performs much analysis between moves, develops more detailed charges for each move, in addition to administering and scheduling each meeting. |

Summary of path game formats.

(3) formulation of policy recommendations. Since path games are unstructured, free-style games, there are few rules. Consequently, the characteristics which distinguish the various formats are the structure of the interaction and the kinds of players involved (which will be covered below).

The players interact through a series of moves. A move consists of the players making a choice at a branch point among a set of proposed options or they can develop own options. In addition, the players are asked to answer some questions regarding the decisions they made. Based on this output, the control team creates a new baseline scenario for next move and provides the players with a new charge and questions which they are expected to answered. In path gaming the main attributes of a move are: the move duration, the inter-move duration, the move scale, and the number of moves in the game as a whole.

The move duration is the length of time used for each move as measured in "real time" (as distinguished from the "game time" which measures the scaled rate at which time moves in the game itself). A move must be long enough for all players to participate actively in the discussions and for all of the relevant issues to be fully investigated, so that the players can make informed choices at the end of the move. In addition, there must be adequate time for administrative matters: briefing the players, drafting the output from the move, and performing any data analysis. If

the game play is "closed," then the time needed for inter-team communications must be considered (e.g., there may be a plenary session where all teams meet together and each team announces its decisions for the move). At the same time, the moves should be kept as short as practical in order to avoid making the game excessively long or cumbersome. As noted in Figure 12 above, moves typically last from one hour for mini-games to four hours for the more involved formats.

The time between consecutive moves, as measured in "real time," is the inter-move duration. This time is useful for both the control team and the players, and as shown in Figure 12 it is one of the main attributes which distinguishes the four path gaming formats. The control team uses this the break between moves for performing various administrative matters such as the printing, copying, and distributing materials. If the control team must perform more than just administrative functions, then the inter-move duration should be long enough for them to carry out the required analysis. This might involve the developing and writing of new scenarios or calculating the budgetary implications of policy decisions made by the players in the previous move. The players need a pause in the game play in order to think about the issues raised in the prior move and to become more accustomed to the path gaming techniques, especially if they are inexperienced players.

The move scale is the length of "game time" per move. It must be large enough for long range issues to be addressed in the game, but not so large that the players have difficulty buying into the new strategic environment in each move. This latter problem was encountered frequently in early path games, when the players would still act as if the "game time" had not changed. Consequently, rather than having each move transport the players five or more years into the future, it is best to have the game time move more gradually with the scale of a move being one to two years, or even less. Several moves or a series of games can be used to get players to address long range issues.

A path game will usually consist of two to three moves, with the last move being a replay of the first move. This feature allows the players to use the insights gained during the course of the game to reconsider the initial choices in move one. After seeing some of the consequences, as reflected in the judgments of the other players and the outcomes as determined by the control team, the players may decide to change their first move. Returning to the example of NATO's conventional force modernization,* the blue team may have decided to forgo the START agreement in move one, and then discovered in move two that without a strategic arms control agreement both the U.S. Congress and the NATO allies

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*See Figure 11 above for the Path Diagram used in this discussion.

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were unwilling to increase their defense spending. Under these circumstances, the START treaty may appear more attractive than the players on the blue team initially believed. During the replay of move one, the blue team may decide to reconsider their opposition to a treaty. The essence of path gaming is for players to consider to consequences of near term decisions on long range goals. The replay of the first move is a valuable mechanism for achieving this purpose.

In addition to the formal structure of the moves, the interaction of the players can be described by the "style" of game play, the number of teams used in the game, and by the ways in which computers are used to aid game play.

The style of play can be either "closed" or "open," which basically refers to how freely the players on different teams can interact. In closed games not only do the teams meet separately, but also the control team regulates all inter-team communications. For example, the red team would not directly speak with the blue team; instead all communication would go to the control team which would determine exactly what portions of the red team's message would be sent to the blue team. This style of play adds realism to the game but at the expense of complexity and cost (because the control team must be large enough to handle this task). The moves must be structured so that inter-team communications do not interrupt the flow of the game. In

open games, on the other hand, the teams are allowed to interact directly (either verbally or in writing) without the control team restricting the flow of information. Open play is less realistic and makes the game less structured, but since the purpose of path gaming is not to model the real world, as such, this loss is not serious. In fact, permitting the teams to interact openly may be beneficial because the members of the blue team (who may be officials in the DoD) may profit from being exposed to the arguments used by the red team (who may be analysts from the intelligence community or academia) without any interference from the control team.

A path game can consist of as few as two teams (a blue team and control team) to as many as four (blue, red, green, and control teams). This color coding scheme is used as a short hand for the following convention:

| | |
|---|---|
| **Blue Team:** | represents the organization, institution, or group which is sponsoring the game, or the main actor(s) making the decisions in the game; |
| **Red Team:** | represents the blue team's main competition or the organization(s) to which the blue team must react; |
| **Green Team:** | represents the other related organizations, institutions, or groups which are not in direct competition with the blue team and are grouped together into one team for simplicity; |
| **Control Team:** | represents higher level decision-making authorities (above those explicitly included in the blue team itself) and is |

used to perform routine administrative functions.

For applications in international security, the blue team could be the executive branch of the federal government (including the National Security Council staff, State and Defense Department officials, and members of the Joint Chiefs of Staff); the red team could be the Soviet Union; and the green team could be a combination of domestic and foreign groups (including the U.S. Congress, the NATO allies and public opinion in Europe and the U.S.). When applied to business and industry, the blue team could be a given company and the red team its main competitor; the green team could represent consumers and various government regulatory agencies.

The number and kinds of teams to be used in a path game is determined by the game's developers when creating the game scenario using a path diagram. There may be no need for a green team if the main issues revolve around the direct competition between two groups. In some cases, there may even be no need for a red team because the main problems may be internal to the blue team. If the key issue is internal disagreements within a given organization on how to approach a problem, then both the red and green teams may be irrelevant.

The size of each team is usually between 10 and 20 people. The blue team is the largest team because it is the

focus of attention. The green and red teams can be fairly

small if either are seen as peripheral actors. The size of

the control team depends on the functions which it is to

perform: in mini-games where it serves mainly to keep a

record of the game and facilitate the game play, the control

team may be three to five people, whereas in closed multi-day

games it can be a dozen or more people. It should be noted

that the more players that are included on a team, the less

chance that all players will be active participants.

Consequently, if the move duration is to be one hour, the

teams not be much larger than a dozen people. The number of

teams times the size of each team will determine the kind of

physical facility needed to play the game, and hence the cost

of the game.

Computers can be used to perform various functions

during a game, and with the widespread availability of

personal computers they can be used extensively even in small

path games. A personal computer linked to an RGB (Red-Green-

Blue) projector can be used to display game materials such as

the description of the scenario, the charge to the players,

or other information required by the players.* A computer is

also a useful too in maintaining a record of the proceedings

of the game. It can be used to display the notes taken by

the control team of the discussions and chart the decisions

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*An RGB projector can display the contents of the computer's
monitor on a screen so that all players can easily view the
computer's outputs.

and choices made by the players. This will help keep the game focused on the key questions. If the game play is closed, then a computer network at a gaming center can be used to facilitate the inter-team communications. Finally, the calculational speed of a personal computer can, in principle, be used to perform quantitative analysis in games which rely on numerical data, e.g., budgets or force levels. The control team or even the players themselves can perform the calculations.

However, two limitations on the use of computers should be noted. First, one should avoid unnecessarily distracting the players' attention away from strategic issues and towards minor details. Excessive use of numerical output from sophisticated computer software can easily cause the players to become more concerned about utility of and assumptions behind the calculations. Second, given the unstructured nature of path gaming, anticipating the precise kinds of calculations that might be required by the players is difficult at best. Thus, the control team can respond to requests for specific calculations, but must be expected to have enough time to formulate the problem more precisely, collect the relevant data, and analyze the results. In other words, the inter-move duration must be sufficiently long (i.e., multi-day or extended games are the only ones where this is feasible). Therefore in most path gaming format,

computers are used only to display game materials and create a record of the proceedings.

## 3.2  GAME PARTICIPANTS.

The character of a path game can change depending on the type of players involved in it.  For the purposes of this report, three different kinds of players will be considered: (1) consultants, or experts from outside of the organization sponsoring the game(s) (e.g., professors from academic institutions or members of consulating firms); (2) staff, or the support personnel, and mid-level management working under a senior level decision-maker; and (3) decision-makers, or senior executives who are authorized to make strategic level decisions.  Figure 13 summarizes some of the differences caused by the involvement of each type of player in the various path game formats discussed above.  Note that not all combinations are possible: it is unlikely that a one-day or multi-day path game using only consultants would be played given that the main purpose of these formats is to educate decision-makers and their staff.  Also the time commitment required for an extended game is probably too large for the direct involvement of a senior decision-maker.

The general role of outside consultants in a path game is to provide expertise in areas beyond the technical capabilities of the sponsoring organization, especially for use on red or green teams.  In addition they can supply novel

| | Consultant | Staff | Decision-Maker |
|---|---|---|---|
| Mini-Game | Preparation for large path game or series of mini-games | Investigate one large scale move or two short scale moves by staff and contractor in one half day; best in part of series. | Decision-makers involved in one game at end of series played by staff |
| One Day | Not Applicable | More detailed investigation of one or more related paths but with little inter-move analysis | Involvement of decision-makers as team leader to add realism |
| Multi-Day | Not Applicable | Very detailed investigation of one or more related paths with some inter-move analysis by Control | Possible involvement at last day with staff playing first several days |
| Extended | Experimental game to further develop technique (logistics, computer programs, etc.) | Staff-level officials meet for half day every 1-3 weeks for one move; control performs analysis between moves; players discuss options in more detail | Not Applicable |

Figure 13. Matrix of path game types.

or unique points of view or approaches to which the other players would not otherwise be exposed. Their fresh insights and thought provoking ideas should help stimulate the discussions during the game and avoid the inbreeding of ideas which can result if only long-time associates were used. Specifically, consultants can be used in the mini-game format in order to carry out the preliminary preparations for either a large path game or a series of mini-games. In this way some of the more important issues can be highlighted and then investigated more efficiently in games involving both staff and decision-makers. Given the complexity of an extended game, a game using primarily consultants may be necessary in order to identify the data and perfect the computer software needed to play such games efficiently. In general, consultants are employed to make more productive use of the players' time by providing a cadre of more experienced, insightful players.

Staff level officials and mid-level management are used to represent the points of view of their organization. Frequently they are the main focus of the path game because they are the ones to be educated so that they are better able to support their superiors. By exposing them to ideas and points of view outside of their normal area of expertise and to novel approaches to problems they should be better able not only to develop options but also to understand the broad array of issues impacting on strategic level decisions

because they will have had some "experience" in making such decisions (i.e., simulated experience during a gaming exercise). The majority of players in all gaming formats are drawn from this group, and they provide much of the inputs used by the team leaders during a game in making decisions.

The main reason for involving senior decision-makers to expose them to issues and opinions with which they do not normally come into contact. In addition, they can add more realism to the games by serving as team leaders. Given their limited availability, the time of a senior decision-maker must be used efficiently, and thus some attention should be given to preparations for a game before their involvement. For instance, in a mini-game format involving them only at the end of a series of games played by their staffs frequently proves to be more productive because then many of the players will be more experienced in gaming and more familiar with the key issues. Using the same reasoning, senior officials can be used on the last day of a multi-day when, as team leaders, they can replay the first move with the benefit of the insights gained by their staff during the first several days of the game. In a one-day game, on the other hand, they should be involved in the entire game in order to benefit fully from the experience; however, adequate preparations should be made to insure that the game runs smoothly. Finally, as noted above, the time commitment for an extended game is too great for their involvement to be

justified. It should be noted that in this format the players must spend a time between meetings preparing for the next move, otherwise the benefits of the long inter-move duration are lost.

## 3.3 LEVEL OF EFFORT.

The amount of resources needed to play a path game is a strong function of the length of the game. Gaming formats with long moves make sense only if they involve a large number of players and consequently large gaming facilities. In addition, games with long breaks between moves make extensive use of the control team to perform analysis. Both factors drive up the cost of a game.

One important consideration in developing a path game is the level of support needed from the control team. This support takes three forms: (1) pre-game preparations, (2) regulation of the game itself, and (3) post-game analysis. Before the game, the control team help the game's sponsors to develop the scenario to be gamed by playing preliminary mini-games in order to refine the paths which need to be explored. The control team can also write the specific scenario for each game and the charge to the players, as well as collect any data that might be required and develop computer programs for use during the game (to analyze data or display gaming materials). The logistics involved in the game can be handled by the control team: scheduling the game, reserving the required facilities,

inviting the players, and distributing the game materials to the players (especially if the materials are sensitive or proprietary).

During the game itself, the control team performs four major functions. First, at the beginning of the game it introduces the players to the game, the techniques to be used, and describes both the scenario and the charge to the players. Second, during the game some members of the control team will regulate the game play by supervising the discussions to insure that the players' charges are fulfilled. In addition, if the game play is closed, then the control team will administer all inter-team communications. Prior to each new move the control team produces summaries of the previous move's outcome (either verbal or written) and presents the players with a new charge. Third, some members of the control team maintain a record of the game's proceedings for use during the game and for subsequent analysis. The use of a computer linked to an RGB projector allows the players to see a summary of the key points made in each move, which helps keep the discussion focused on the most important topics. Finally, the control team can analyze data as requested by the players, although it should be noted that this is done primarily between moves when more time is available. The size of the control team, and hence the cost, is driven by the need for extensive analysis, monitoring of

inter-team communications, and the development of detailed charges for each new move.

Following the game, the control team is responsible for providing a summary of the game for use in future games. The summary should contain not only the main findings and important points raised regarding the game's topic, but also the methodological issues encountered during the course of the game and how they were resolved. It may also be necessary to provide post-game briefings to either the players or the game's sponsor, especially if a series of related path games were played over an extended period of time.

The second factor which affects the overall cost of a game is the facilities needed in order to play the game itself. The simpler game formats, such as the mini-game format, are inexpensive primarily because they require little more than a seminar room large enough for one or two dozen people (the players plus the control team and support personnel). On the other hand, the more complex formats may require the use of specialized gaming centers which have interconnected rooms for each team to meet separately and be monitored by the control team. A large auditorium is needed for plenary sessions when all teams meet jointly. In addition to standard audio-visual equipment, computer terminals should be available to both the control team and

the players.*

In the four chapters that follow, the main
characteristics, strengths and weaknesses of each of the four
path gaming formats will be discussed.  These chapters will
thus provide a catalog of gaming formats from which the
reader may wish to choose.  To aid in deciding which format
is most suitable for a given application, the final chapter
provides some guidelines in selecting the optimal gaming
format.

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*An example of a government owned gaming center is the War
Gaming and Simulation Center (WGSC) at the National Defense
University in Ft. McNair, Washington, D.C.  This center has
an 8,000 square foot facility with a staff of 23 personnel.
The computer hardware available at the center is a
VAX 11/785.  The center has an auditorium with seating for
66, three principal game rooms, and a closed circuit TV
system which links together the auditorium and the gaming
rooms.

SECTION 4

MINI-GAME FORMAT


In this chapter the simplest and least expensive gaming
format will be described in terms of the basic purposes that
it can fulfill, the specific gaming techniques involved, and
its main strengths and weaknesses.  Appendix D at the end of
this report contains a handbook for the development of mini-
games, also known as "computer-aided decision simulations"
(CADS).


4.1  PURPOSE.

The main attribute of a mini-game is its simplicity, but
like many simple tools it can be used best only for certain
types of applications.  A mini-game, because it involves a
small group of players, can help understand the main
parameters of a given problem, rather than actually resolving
a problem.  However, the problem addressed in a mini-game
should be relatively limited in scope.  In particular, it
should be sufficiently narrow for a blue team, supplemented
by individual players representing red and green teams, to
address all of the major questions.

Within these constraints, a mini-game can bring together
a group of knowledgeable officials and outside experts to
discuss a set of interrelated issues in the format of a
structured seminar.  A single mini-game can investigate one

path with two branch points or two pa‏ hs emanating from a single branch point. Alternatively, ı series of mini-games can explore several different paths, ı process which resembles an extended game.* This format is best suited for identifying issues and questions which have not be adequately considered, but must be in order to obtain the preferred future goal. One possibility is that the players could identify an organization, individual, or group either that is not involved in the current decision-making process or whose expertise is not being utilized. While going through a simulated decision-making process, the players themselves can become better educated both in the substance of the issues under consideration and in the best means of approaching a problem. Given the severe time constraints involved in a mini-game, most of the players must be experienced in path gaming, and thus the use of mini-games for education is limited to a handful of people per game.

In order to understand more fully the purpose of a mini-game, it is worthwhile to consider some potential applications using the example of NATO's conventional force modernization discussed in Section 2 above.

The problems associated with cooperation between the U.S. Army and Air Force in developing long range strategies

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*See Section 7 for a discussion of extended games. A key difference is that an extended game examines only one path in great detail, while an series of mini-games study several paths in less detail.

for modernizing U.S. conventional forces used to meet America's many foreign commitments is one that could be studied using the mini-game format. This issue may have been identified in previous analyses as an important problem. The impact of severe budgetary constraints and restrictions imposed by possible arms control agreements, especially if arms control is a high priority of the game's President, are two issues that could be investigated by a single blue team. The major actors who would be represented in the game could include: President, National Security advisor, Secretary of Defense, Chairman of the Joint Chiefs of Staff, Army and Air Force Chiefs of Staff, other representatives from the Army and Air Force as indicated by pre-game analysis, and the Chairmen of the House and Senate Armed Services Committees. These players could then be supplemented by an expert on the Soviet Union and one on NATO.

The purpose of the game would be to gain an understanding of the trade-offs that would have to be made between Army and Air Force programs, who should be involved in making these trade-offs, the relevance of European concerns in these trade-offs, and the questions that would have to be answered before entering any arms control agreements. The educational purposes of the game would be satisfied if, for example, the military representatives would became more sensitive to Congressional concerns.

A second possible application might be the development of a joint U.S.-European plan for NATO force modernization, including industrial cooperation, arms control and burden sharing. However, in this case the key issues would involve the interactions between the blue and green teams and a mini-game format would thus not be appropriate. If either the U.S. or Europe were treated as a unitary actor (e.g., represented by a single player) then much of the value of gaming would be lost. A mini-game format might be useful if pre-game analysis indicated that this larger problem could be broken down into smaller components, which could then be modeled using a mini-game.

4.2  DESCRIPTION.

As discussed above, two main characteristics of a mini-game are the short move duration and minimal inter-move duration. Moves are approximately one hour long and are played essentially without any break between moves. These two attributes combine to place severe time constraints on the players. The control team and the team leader must ensure that discussions do not become sidetracked on irrelevant issues, and that the charges given to the players are addressed. Consequently, only one team (excluding the control team) can be accommodated into this format; there is no time for inter-team communications.

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The basic structure of the game is therefore very simple: (1) at the beginning of the game the players are briefed on the scenario and given their charge for the first move; (2) move one is played for approximately one hour; (3) the control team quickly summarizes the outcome of the first move and gives the players the charge for the second move; (4) move two is played for one hour; (5) again the control team summarizes play up to this point in the game and gives the players the charge for the final move; (6) move three is played for one hour.* The final move may be either a replay of move one or a general discussion of the game, depending on which the control team thinks would be most beneficial. A sample agenda for a mini-game is shown in Figure 14.

Since only one team is involved in a mini-game, the style of play is inherently open and all players can freely interact. The "red" team, for example, is represented by one player, and the blue team players are able to get his or her reaction to their proposals directly. The gaming facility required for this format is very simple: a seminar room able to accommodate 12 to 18 people comfortably and several personal computers connected to a RGB (red-green-blue) projector. The control team needs to consist of only three

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*Note that only three hours is nominally allocated to game play with the remaining hour being taken up by the briefings before the game and before each move and used to provide the players some leeway if moves run over one hour.

|          TIME          |          ACTION          |
|------------------------|--------------------------|
| 10:00 - 10:15am        | Introduction to game and pre-game briefing |
| 10:15 - 11:30          | Move 1                   |
| 11:30 - 12:30pm        | Move 2                   |
| 12:30 -  1:00          | Working lunch and review of Moves 1 and 2 |
|  1:00 -  2:00          | Move 3                   |

Figure 14.   Sample agenda for mini-game.

to five people: a team leader to moderate the discussions, one or more computer operators, and a someone to take notes of the discussions. In this application, computers are used only to display gaming materials and a record of the game's discussions.

Given the short length of the game (i.e., four hours), senior decision-makers can easily participate. However the severe time constraints require that most of the players, and especially the team leader, be experienced players. No more than a few new players (which most likely includes senior decision-makers) can thus be accommodated into this format. The majority of the players should be either outside consultants or staff level officials (who can become experienced players by participating in several preparatory mini-games).

The need for pre-game briefings can be minimized by controlling the individuals invited to participate in the game: only officials or consultants who are already familiar with the specific topics addressed in the game should be included. In this format it is unwise to invite an organization to send their own representative because then the control team will not be able to insure that this person will be "up to speed" and capable of actively participating in the game.

The logistics of a mini-game are considerably simpler than those associated with the other game formats discussed

below.  The short length minimizes scheduling conflicts,
which for long games can become a problem.  The small number
of players simplifies the control over their selection and
reduces the problem of player turnover during the game.  In
the longer game formats, some players may not be able to
attend the entire game, and their replacements will need to
be briefed on the status of the game and their role.  This
problem is not present in mini-games.  In addition,
confidential gaming materials can be controlled easily,
allowing sensitive topics to be discussed.


4.3   STRENGTHS.

The main strengths and weaknesses of this format in
satisfying the three main purposes for path gaming are
summarized in Figure 15.  The discussion in this section and
the next will further explain the main points shown in this
matrix.

The chief value of this format is its ability to help
the players identify issues which have not received adequate
attention.  Frequently, when extremely complex problems,
especially those involving long range planning, have many
facets which must be considered early in the process and
before they become major obstacles.  Path gaming and
particularly its most open and free-form style is a valuable
tool in aiding senior decision-makers identifying these
potential problems.  General examples of problems which can

| Purpose | Strength | Weakness |
|---|---|---|
| Education | Expose small group to new issues and gaming methods | Unable to handle more than a few new players |
| Issue Identification | Locate many new features to problems by combining expertise of players | Issue must be small in scope and modeled with one team |
| Policy Recommendation | Suggest broad change in strategies | Limited by inability to include any detailed analysis in game |

Figure 15. Strengths and weaknesses of mini games.

be identified by path gaming but which might otherwise go unnoticed include organizations or individuals who either are not or feel that they are not adequately involved in the decision-making process. The investigation of the complex interrelationships of the variables involved in the process can reveal useful insights into how seemingly unrelated issues can impact the attainment of a given long range goal.

A second strength of mini-games stems from their low cost: they can be easily replayed in order both to research a set of related paths and to create a set of experienced players. The other formats are all relatively expensive to run and thus must be use sparingly, but mini-games, although less powerful tools, can be played repeatedly and thereby achieve impressive results. In many issues the detailed investigation of a single path into the future is not useful given the degree of uncertainty associated with many of the relevant variables. A series of mini-games, each of which can provide a quick overview of a different path, can then given a senior decision-maker more useful information.

In addition to creating a cadre of experienced players (assuming that many of the same people are used for the entire series of games), mini-games can be used to educate a small group of people in both path gaming and the substantial issues dealt with in the game. The severe time constraints of this format mean that the game play must be efficient and the use of too many novice players will slow down the game.

However, the use of a few new players with an experienced group of players is an excellent device to introduce people to path gaming.

Finally, the mini-game format can be used to make policy recommendations to deal with problems that the players have identified. Given that the games are very unstructured only broad recommendations regarding long range strategies can be made. A series of path games, when their overall results are combined, can help develop very reasonable policy options because the implications of each will have be already examined.

## 4.4 WEAKNESSES.

This gaming format, however, is not without its weaknesses. Mini-games are optimized for the purposes cited above, and thus are ill-suited for other functions. For example, if sponsor wishes to educate a large number of people in the complexities of a given issue, then this format would not be a good alternative. The need to keep the number of players to a minimum, the use of many experienced game players, and the severe time constraints mean that mini-games cannot be used efficiently to expose many people to the intricacies associated with a problem or to broaden their perspectives. Some of the other gaming formats discussed below are better adapted for this purpose.

Since a mini-game is extremely unstructured but also operates under severe constraints, the players do not have an opportunity to investigate issues in any detail. They must restrict themselves to broad, strategic concerns. The control team has little time between moves to develop detailed new charges for the players for each new move, and even less opportunity to perform quantitative analysis. The result is that mini-games cannot be used to develop specific recommendations regarding, for instance, investment strategies, explicit changes in particular programs, or the other precise policy options.

# SECTION 5

## ONE-DAY GAME FORMAT

This section will cover a second format used frequently in path gaming, namely the one-day game. Its main purpose will be discussed first, followed by the gaming techniques that it employs and its basic strengths and weaknesses.

### 5.1 PURPOSE.

The primary objective of a one-day game is to involve a large group of people in discussing a single major issue for which they all are responsible but with which they may not be fully familiar. Many problems that the Defense Department, other government agencies, and private industry must deal with are extremely complex with many interrelated variables. Many different groups or organizations may be working on different aspects of the problem, but without understanding how their efforts affect each other. This understand can be increased by having key members from each relevant group participate in a path game.

Since, by definition, most of the players will be inexperienced in gaming, the format used must accommodate them. A one-day game will frequently be a good compromise. The severe time constraints of the mini-game format are significantly relaxed, and the large time commitment of a multi-day or extended game is avoided. The issue addressed

in the game need not be as narrow in scope or as well defined as with these other formats. The use of several teams will encourage players to adopt alternative perspectives (e.g., Americans may adopt the perspective of Europeans or mid-level manager may adopt the longer term perspective of a senior manager).

A possible application of a one-day game is the development of a joint U.S.-European plan for the modernization of NATO's conventional forces under the constraints of arms control and limited defense budgets. The purpose would be to expose U.S. officials responsible for programs in the area of the general purpose forces to European concerns in such areas as burden sharing, risk sharing, threat perception, and economics. A mini-game would be inappropriate because, in this case, the European perspective is not a peripheral one and a green team must be explicitly included in the game.

Many other types of issues, however, cannot be handled within the constraints of this format. If, for example, the question was to develop recommendations for overcoming problems in U.S.-European industrial cooperation in joint weapon programs, then the use of inexperienced players and the relatively short inter-move duration would make it difficult for the players to assimilate the necessary information in an unfamiliar environment. The players' attention should be focused on understanding the problem and

becoming acquainted with gaming techniques, not on actually
formulating policy recommendations. At the same time, if
these officials become better educated, clearly they are
better equipped to support senior decision-makers in
constructing policy options.

5.2 DESCRIPTION.

The main difference between a mini-game and one-day game
is the relaxation of the former's time constraints which
permits the use of several teams and inexperienced players.
A one-day game, as the name implies, takes one full work day
to play. Each move lasts for one to two hours with a break
of less than one hour between moves. Thus a game will
consist of approximately three moves. Because the issues
which are addressed in a one-day game are generally broader
in scope than is the case with mini-games, the scale of each
move is typically longer, e.g. one to five years.

The structure of a typical game is the following:
(1) Before the game starts, the control team introduces the
players to path gaming, briefs them on the scenario, and
provides each team with their charge for the first move. In
this gaming format, this step is extremely important because
it must be assumed that the players are unfamiliar with path
gaming and must therefore be "brought up to speed" quickly in
order to avoid wasting valuable game time. (2) The first
move is played. The general design of a move is first for

the teams to meet separately to discuss their strategy for the move, then for all teams to meet together in a plenary session, and finally for each team to generate the outputs required by their charge. (3) During the inter-move break, the control team analyzes the output produced by all of the teams and develops new charges. The players can use the break to digest the materials presented to them and prepare for the next move.* (4) The control team then briefs the players on the outcome of the previous move (as determined by the control team using the players' outputs) and provides them with their new charge for the next move. Steps 2 through 4 are then repeated for each move. Figure 16 is a sample agenda.

Unlike mini-games, one-day games can be played as either open or closed. Note, however, that if play is to be closed then a larger control team may be needed in order for it to regulate all of the inter-team communications. A closed game may also require the use of a formal gaming center which has the facilities to permit the teams to meet individually and an auditorium large enough for plenary sessions.

Computers can be used more extensively in the one-day game format for not only displaying game materials, but also

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*In addition, players can use this break for more practical purposes, namely contacting their office, returning telephone calls, or any other business related activities. In fact, the developers of a game should not forget that the players do have responsibilities beyond playing the game and should make accommodations for this whenever possible.

|             TIME            |                 EVENT                      |
|-----------------------------|--------------------------------------------|
| 08:30 AM  - 09:30 AM        | Introduction and pre-game briefing         |
| 09:30 AM  - 11:30 AM        | Move 1                                     |
| 09:30 AM  - 10:30 AM        | Team discussion                            |
| 10:30 AM  - 11:00 AM        | Plenary session                            |
| 11:00 AM  - 11:30 AM        | Team decisions                             |
| 11:30 AM  - 12:00 PM        | Break                                      |
| 12:00 PM  - 02:00 PM        | Move 2                                     |
| 12:00 PM  - 01:00 PM        | Team discussion and working lunch          |
| 01:00 PM  - 01:30 PM        | Plenary session                            |
| 01:30 PM  - 02:00 PM        | Team decisions                             |
| 02:00 PM  - 02:30 PM        | Break                                      |
| 02:30 PM  - 04:30 PM        | Move 3                                     |
| 02:30 PM  - 03:30 PM        | Team discussion                            |
| 03:30 PM  - 04:00 PM        | Plenary session                            |
| 04:00 PM  - 04:30 PM        | Team decisions                             |
| 04:30 PM  - 05:00 PM        | Closing comments                           |

Figure 16.   Sample agenda for one-day game.

for controlling inter-team communications and analyzing the output generated by the players. This should allow the control team to develop more detailed and realistic charges for the players, something that may be required given the low level of experience possessed by many of the players.

Typically, a one-day game involves anywhere from 40 to 50 people, who are divided into three teams as well as a control team. The teams are lead by a senior decision-maker and composed of staff officials, mid-level management, and outside consultants. This combination not only adds realism to the game, but also allows a senior manager's time to be used efficiently because he or she can draw upon the experience of the other players for both technical advice and help with gaming techniques.

In this game format, the level of support provided by the control team can be considerable, especially if the play is to be closed. Since many of the players are new to path gaming, much pre-game analysis is needed: developing briefing materials to acquaint them with gaming quickly, detailed charges for each team, and background material on the game's main topic. Some players may request or require briefings before participating in the game. However, post-game analysis, except for documentation, may be less extensive given that the purpose of this format is education and the relevant officials would have been directly involved in the game.

5.3  STRENGTHS.

The main attributes of one-day games are given in Figure 17 below.  This matrix summarizes the ability of this gaming format to fulfill the major goals of path gaming.

The chief value of this format is its ability to expose a large number of people to new concepts and ways of approaching a major problem in a thought provoking manner. When contrasted with more traditional briefings, reports or seminars, path games can readily be seen as superior in many respects.  First, the participants are actively involved in the learning process, as compared to passive on-lookers.  For many people learning-by-doing is more informative -- and interesting -- than learning-by-watching.  Second, gaming has more impact, and thus more chance of changing the ways officials actually approach their jobs after the game.  The same basic material presented in traditional formats is likely to be ignored.

A concrete example might help emphasize this point.  The first path game was played in Newport, Rhode Island in 1984 on the general topic of the Strategic Defense Initiative.* During the course of this game the differing perspectives on S.D.I. that separated the United States from its European allies became apparent and the blue team was forced to

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*See Appendix C at the end of this report for a short description of some path games.  These summaries will hopefully provide some more concrete examples of the gamj techniques discussed in the body of this report.

| Purpose | Strength | Weakness |
|---|---|---|
| Education | Expose large group to new concepts and approaches | May be expensive and require much pre–game analysis |
| Issue Identification | Locate unresolved problems in broad policy questions | Result is indirect outcome from process of education |
| Policy Recommendation | Suggest broad change in strategies | Limited by inability to include any detailed analysis in game |

Figure 17. Strengths and weaknesses of one–day game.

confront this directly in order to achieve their tasks in the game. Simply being told about Europe's misgivings about U.S. policies regarding S.D.I., or reading about them in an analysis did not have the same impact as actually playing out a hypothetical planning exercise. Senior decision-makers became more sensitive to the impact of their decisions on U.S. relations with NATO.

This example leads immediately to the second main strength of this gaming format: namely, the ability to help identify key unresolved issues. By exposing the appropriate officials to new ideas, material, and opinions they will be better able to locate problems of which they were previously unaware. This outcome is an indirect result of their education during the game. In other words, the players may not be able to identify new issues in the actual game itself; this may occur after they have had time to digest the new material more fully. In fact, this possibility is precisely why the general purpose of education is a valuable one.

5.4 WEAKNESSES.

While this gaming format may help officials identify issues requiring their attention, it is less useful in formulating actual recommendations to resolve these problems. The time constraints, while less severe than is the case with the mini-game, still are such that the players' attention should be directed towards a single goal, i.e., in this case

education. It is thus unlikely that any concrete policy recommendations will come out of a one-day game. In order to improve its capability in this regard, the control team would have to carry out much pre-game analysis and thoroughly brief the players prior to the game itself. This might allow the players to concentrate on resolving a given problem, but it would not be a cost-effective solution. Other path gaming formats, such as mini-games and extended games, are better suited towards this goal.

Unlike the mini-game format, a one-day game can become an expensive operation. In order to accommodate the large number of players (40 to 50 people), a large facility is required. A formal gaming center, such as that at the National Defense University, may be necessary if the game play is to be closed and sensitive material is to be used. Scheduling can then become complicated, especially compared to the simpler mini-games. Consequently it is not cost-effective to play one-day games for the purpose of conducting research on a complex topic. Other formats, such as a series of mini-games, are frequently a superior alternative.

SECTION 6

MULTI-DAY GAME FORMAT


This section will discuss a third format which was used
early in the development of path gaming.  Although the multi-
day format has several serious drawbacks, under certain
circumstances it may prove to be a reasonable alternative.
After describing the purposes for which this format is suited
and its general characteristics, this chapter will cover the
major strengths and weaknesses of multi-day games.


6.1  PURPOSE.

The multi-day gaming format is best adapted for the
purpose of exposing a large number of people to a very
complex and intricate problem.  In particular, the issue must
be sufficiently complicated for the control team to need more
than the short break between moves available to them in the
one-day format in order to prepare for each move.  In many
respects, a multi-day game combines the advantages -- and
disadvantages -- of both the one-day and extended games.  It
allows the players to consider a problem in more detail than
is possible in a one-day game, without the time commitment of
an extended game.  However, at the same time the players must
be willing to devote three to four consecutive mornings to
the game, an obligation that many busy officials may find
difficult to keep.  Consequently, the developers of a path

game should consider carefully  whether the need to examine a given problem in the detail possible in this format is worth the problems inherent in it.  These drawbacks will be described in more depth in the sections below.

An example of an issue which could be dealt with in a multi-day game is the development of a joint U.S.-European plan for the modernization of NATO's conventional forces. Except in this instance more attention could be given to the details of a specific aspect such as the problem of "burden sharing."  In particular the players could be asked to address the problems associated with the economic implications of increased defense sharing, the interrelationships between NATO military strategy and trade relations, and the implications for the domestic economies and politics of the member countries.

The control team in this game would need more time between moves for evaluating the probable impact of the decisions made in the prior move on the overall military, economic and political environment for the next move.  In a one-day format there would not be adequate time for such analysis.  In addition, the control team would need time to write realistic and concise charges for the players.  The 24 hour break between moves could prove to be adequate if the control team took sufficient preparations in order to use this time efficiently.

The purpose of this game, it should be emphasized, would be to educate the players in the key issues surrounding the problem of burden sharing (e.g., to make them more aware of the European perspective on burden sharing), rather than formulating specific policy options to overcome obstacles in order to achieve a specified goal or the test proposed solutions. The players would not have enough time to handle these last two goals.

## 6.2   DESCRIPTION.

The main attributes of the multi-day game format are: the duration of the moves is four hours, which is much longer than in other formats discussed above; and the inter-move duration is one day, with moves being played on consecutive mornings and the control using the time in between for preparing each move. Given the complexity of the problems for which this format is designed, at least three and typically four teams (including the control team) are included. A game lasts for three, or possibly four, moves and the last move is usually a re-play of the first move when, as noted in previous formats, the players are encouraged to reconsider their initial decisions in light of the outcome of the previously played moves.

The basic structure of a game is the following:
(1) Before the first move, the players are briefed by the control team on path gaming, the scenario to be investigated,

specific information needed for the first move, and the

charge to be fulfilled by each team. (2) The first move is

played with the teams first meeting separately to discuss and

fulfill their charge and then meeting in a plenary session to

exchange outputs with the other teams under the supervision

of the control team. (3) During the inter-move break the

players are permitted to leave the gaming center* and the

control team uses this time to collect and analyze the

outputs produced during the move and to prepare both a

description of the new strategic environment and the specific

charges for the players for the next move. (4) On the

following morning the players are briefed by the control team

on the results of their analysis. (5) The second move is

played using the same structure as the first move. The

process given in steps 2, 3, and 4 are repeated for each

move. An example of an agenda for a multi-day game is given

in Figure 18. In this variant, the first two moves occur on

the first day.

An alternative structure for a move is to have the teams

meet separately for approximately one hour in order to hold

preliminary discussions on their charges. All of the teams

then meet in a one hour plenary session during which the

teams can interact either freely or under the strict

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*As noted in previous sections, it is important to consider
that the players have other responsibilities and provide them
time during the game for routine business activities. The
considerable time commitment involved in a multi-day game
makes such considerations an essential part of the game's structure.

Day 1

| 0830-0845 | Convene |
| 0845-0900 | Welcome |
| 0900-0930 | Orientation Briefing |

0930-1330    Move 1

| | - | Teams Prepare Decisions | 0930-1130 |
| | - | Teams Report | 1130-1200 |
| | - | Teams Make Decisions (Working Lunch) | 1200-1330 |

1330-1400    Teams Break

1400-1700    Move 2

| | - | Teams Prepare Decisions | 1400-1530 |
| | - | Teams Report | 1530-1600 |
| | - | Teams Make Decisions | 1600-1700 |

Day 2

0900-1200    Move 3

| | - | Teams Prepare Decisions | 0900-1030 |
| | - | Teams Report | 1030-1100 |
| | - | Teams Make Decisions | 1100-1200 |

1200-1630    Move 4 (Replay of Move 1)

| | - | Teams Assess Positions (Working Lunch) | 1200-1400 |
| | - | Teams Report to Seminar | 1400-1630 |

1630-1645    Closing

Figure 18.  Sample agenda for multi-day game.

supervision of the control team, depending on whether the game is open or closed. The teams then meet separately for a second time in order to make their final decisions for the move and present the results to the control team. This move structure is somewhat more complex, but the players can benefit from the plenary session prior to finalizing their decisions for a move.

The teams can be comprised similarly to those used in one-day games: a senior decision-maker for the team leader and the remainder of the team consisting of a combination of staff officials, mid level management, and outside consultants. However, another arrangement can also be used: during all but the last move the teams can be comprised of mid level managers, staff officials, and consultants. On the last move (which would be a replay of the first move), the teams can be led by senior officials who have been briefed on the outcome of the first several moves. The last move is then similar to an expanded mini-game, where the team leaders can benefit from the insights and experience gained by the other players during the first several moves.

The total length of a multi-day game is from three to four days. Four days would be used only if senior officials were to be involved on the last move, following an thorough investigation by the other players on the first three days. More typically, multi-day games are restricted to three days because much longer is impractical due to scheduling

conflicts and expense and much shorter provides only a marginal benefit over a one day game.

The control team in a multi-day game is relatively large, especially if the game play is to be closed. In addition, the members of the control team are needed to carry out a considerable amount of analysis over the inter-move break, and in order to fulfill this requirement many analysts are needed and computers are used extensively. But perhaps one of their most important task is the preparing of the briefing materials used at the beginning of each move. They help orient the players in the new strategic environment produced in each successive move and understand the implications of their decisions from previous moves. These materials must be prepared carefully and presented to the players effectively and convincingly.

The logistics of multi-day games can easily become quite complicated. First, they require the use of a gaming center and must be scheduled around the availability of the center. This availability must then be matched to the schedules of 40 to 50 potential players, which include several top level managers. While clearly these problems are not formidable, they do restrict the use of multi-day games. In contrast, mini-games can easily be organized and carried out on relatively short notice. A further complicating factor is the problem of player turnover. Frequently a person may be unable to participate for the entire three days of the game

and he or she may need to be replaced, for example, by another representative from the respective organization. If this problem occurs too frequently, the continuity of the game play can become disrupted. Finally the simple cost of bringing together a large number of people for an extended period of time, renting the gaming center, and the other associated expenses often make this gaming format an unattractive alternative.

6.3  STRENGTHS.

The strengths and weaknesses of multi-day games are indicated in Figure 19 below and discussed in this section and the next.

Some issues are sufficiently complex and the long range implications of the decisions involved in resolving them sufficiently difficult to grasp that a gaming format is needed which provides the players with more time. A multi-day game fulfills this requirement. In this format the control team has an opportunity to provide the players with realistic -- and defensible -- changes in the strategic environment produced by their previous moves. Educating knowledgeable officials using path gaming techniques is impossible unless they as players "buy into" both the initial scenario and the modifications in it caused by their actions and decisions. Since path gaming's basic purpose is the understanding of the long range implications of present day

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| Purpose | Strength | Weakness |
|---|---|---|
| Education | Expose large group to issues related to very complex issue | Extremely expensive to play game, large time commitment |
| Issue Identification | Locate unresolved problems in broad, long range policy questions | Poor cost—effectiveness due to expense and player turnover |
| Policy Recommendation | Suggest more detaile changes in strategy. | Poor cost—effectiveness due to expense and player turnover |

Figure 19.   Strengths and weaknesses of multi-day game.

strategic decisions, this problem lies at the heart of a path game.

In the case of complex issues, multi-day game may prove to be the only viable alternative. A shorter inter-move duration than one day does not give the control team enough time for performing the necessary analysis and preparing the briefings for the next move. A longer inter-move duration reduces the impact of the game as the players do not recall the details of previous moves during a long break.

The main drawback of the format is the large time commitment it makes on the players. They must be able to devote three to four consecutive days to the game. This problem has two adverse consequences. First, it reduces the likelihood that some officials would be willing to participate at all, and if their specific expertise is desired in order to provide a special perspective, then the quality of the game will suffer. Second, some players may be unable to participate for the entire game and may then send a replacement. These new players, who will be unfamiliar with the previous moves and possibly with gaming techniques, can disrupt the continuity and flow of the game.

6.4  WEAKNESSES.

The main weakness with this format is its poor cost-effectiveness for both research and, under some conditions, education. A multi-day game is expensive and cumbersome and

thus its use requires a large payoff in order to justify the cost. Except for educating a large group of people in very complex issues, this justification is often lacking. In many cases, this format may result in a slightly better game than the other alternative, but the marginal improvement may not be worth the additional costs.

Cost-effectiveness is especially a problem if the goal is research, either in the form of identifying key issues or formulating broad policy recommendations. For example, one-day games cannot be used effectively for research because of the limited time available for each move. A multi-day game does give the players more time for reflection, and thus there is a greater chance that they will be able to identify new potential problems. However, not only it is difficult to defend this modest improvement, but also other alternatives exist which are considerably more cost-effective if research is the primary objective (e.g., a series of mini-games).

Even in the area of education, other alternatives should be seriously considered. One-day games with adequate preparation can accommodate many issues. If the intended audience is small then a series of mini-games may prove to be an adequate solution.

## SECTION 7

## EXTENDED PATH GAMES

The final major path gaming format is an extended game,
whose name reflects its main attribute: a long break of one
or more weeks between moves.  As in previous chapters, the
basic purpose that this format serves will be discussed
first, followed by a description of its most important
features and its strengths and weaknesses.


7.1  PURPOSE.

Extended path games are used primarily for the detailed
examination of a well-defined problem, or path, by a group of
staff level officials, mid level managers, and outside
consultants.  In addition to carrying out basic research into
policy options, these games can be used to educate some of
the players in the complexities of an issue or to change
their perspective from immediate, short-term problems to
strategic issues and the long term implications of current
decisions.  This format is best suited for issues which
required extensive amounts of data analysis, e.g., ones where
large amounts of budgetary data are involved.

In some respects an extended game is similar to a series
of mini-games, but with some important differences.  An
extended game is restricted to a thorough examination of a
single path which was previously identified as one requiring

further study. It is strongly focused on one particular aspect of a problem and in each move the players develop strategies design to achieve a specified goal. While the extended game format is more structured and gives a path game more "game-ness" than the other formats, a series of mini-games retains the unstructured, free-form style of other path game formats. No attempt is made to provide more organization to the game play. Each game considers a different, but related path which connects the current strategic environment to possible future ones. A series of mini-game, in fact, could be used in preparation for an extended game, with the former used to identify the scenario to be used in the latter.

A possible example of an issue which could be examined in an extended game is the problem of U.S.-European cooperation in a joint weapons program. This choice, however, presumes that this issue was determined to be an important part of overall NATO conventional force modernization. As noted above this kind of topic is not well suited for a one-day game because in this format the inter-move duration it too short for the necessary analysis. Although the extended game format can be expensive, it is clearly better to play out a simulation on this topic before proposing it as the centerpiece of a major NATO modernization program.

In this game there could be three moves, played during three separate meetings one or more weeks apart, covering the following basic issues: (1) the design phase of the joint weapons system, during which the problems associated with matching the technical and military requirements of each of the NATO allies to the specific system can be addressed; (2) the testing and development phase, during which the problems of technology transfer (e.g., the civilian applications of military technologies) and modifications of the system to meet the changing needs of the NATO allies can be considered; and (3) the production phase, where the players can be asked to make the difficult decisions of who should produce which parts of the system and then integrate them together, taking into consideration the obvious political and economic implications of these decisions. The purpose of this game would be to develop an understanding of how best to overcome the political, economic, and technical obstacles which could hinder the completion of this program.

In contrast, this format is not well suited for the examination of ill-defined problems. If the players could easily identify variables not considered by the game's developers but that cannot be ignored, then an extended game would be inappropriate. Such problems are best handled by mini-games. An extended game cannot be radically restructured during the course of the game itself, but the

basic orientation of a series of mini-games can -- and frequently will -- change before its completion.

7.2  DESCRIPTION.

The most important attribute of an extended game is the use of the extremely long breaks between moves by the control team for data analysis.  These breaks vary from one week to three weeks, depending on how much time the control team requires and the scheduling problems involved in organizing each move.  The moves themselves typically last for a half day, or four hours, and a game consists of three moves.

The basic structure of an extended game is the following: (1) At the beginning of the first meeting of the players and before the first move starts, the control team briefs the players on gaming techniques, describes the general scenario to be studied and the specific path which they are to explore, and then provides them with the necessary background material.  Since this format is more structured than the other one considered above, this pre-game briefing is more important, both in terms of the description of the methodology and the scenario.  If care is not taken in this task, then the overall quality of the game will suffer. (2) Next the actual move is played for the remainder of the first meeting.  The basic organization of the move is similar to that used in a multi-day game: first the teams meet separately to discuss the tasks they were charged with,

second a plenary session is held during which inter-team

communications are exchanged, and finally the teams again

meet separately to make their decisions in order to fulfill

their respective charges.  (3) After the end of the meeting,

the control team collects and then analyzes the outputs

produced during the first move.  Since the inter-move

duration is on the order of weeks, this analysis can be very

detailed and include modeling work in order to evaluate

quantitatively the impact of the players' decisions on budget

projections, production facilities, and so forth.  This

analysis is then used to produce the new briefing and

background materials for the next move.  In addition, the

players are expected to make use of this period of time to

discuss the game with their colleagues, reflect on the

results of previous moves, and prepare for the next move.  If

both the control team and the players do not use the inter-

move breaks for these purposes, then the extended game format

will not work.  (4) The second and subsequent moves are

scheduled and played in the same manner as the first move.

The game play can be either open or closed, depending on

how the plenary sessions of each move are to be handled.  An

extended game may include only two teams, namely blue and red

teams, because the use of a third, green team can greatly

complicate the scheduling of the moves.  With 10 to 12

players per team, there will be between 30 and 40 total

participants, including the control team.  Note that since

the control team is called upon to perform more tasks in this format than in the previous ones, it will be fairly large.

The majority of the players will be mid level managers, staff level officials, or outside consultants. Given the level of detail in this format and the large time commitment, it is unlikely for senior officials or decision-makers to be directly involved in the game itself. As noted above, all players would have to devote a considerable amount of the inter-move breaks on the game, and many senior managers would not be able to do this.

The total length of a game can be one to three months, and thus the level of support required is high. The control team would not only be needed for extensive pre-game preparations and in-game administrative support and data analysis, but also post-game evaluations become more important because senior decision-makers would have to be briefed on the results of the game. In other words, in this format the process of playing the games and the education that occurs during that process is not the only purpose of the games. The players are expected to help formulate policy recommendations for use in overcome real obstacles in the real world. These recommendations should be documented, their rationale defended, and thoroughly evaluated. The game's sponsors, supported by the control team and possibly by post-game evaluations from some of the players, should carry out this examination.

The logistics of an extended game can become complicated because a low player turnover is vital. Consequently, the scheduling of each move must be arranged around the availability of not only a gaming center, but also all of the specific individuals playing in the game. The difficulties can be seen by the following: the approximate time for each move is fixed to within a week by the requirements of the gaming format, the availability of the gaming center may then reduce the possible days to a handful, and then from these few days one must be found when nearly all of 30 to 40 officials are available. This task can be accomplished only with advanced preparations.

A low player turnover is an essential aspect of this format because a considerable amount of effort will be expended on bringing the players into strategic mind-set of the game. They must be familiar with the previous moves, accept the changes produced in the strategic environment of the game, and act as if they were in it (e.g., they must be able to play the game as if they were 5 to 10 years into the future). If new players were introduced constantly into the game then this continuity would be disrupted and the control team would have to spend much of each meeting on briefing the new players.

7.3  STRENGTHS.

The ability of the extended game format to satisfy the three main purposes of path gaming is indicated in Figure 20 below. The last two sections in this chapter will further discuss the main points noted in this matrix.

An extended game is the only gaming format designed for formulating policy recommendations. The other formats discussed above are useful for educating key officials or helping to clarify the major issues in an otherwise ill-defined problem. These other format are specifically designed around these two purposes, and thus cannot handle the more demanding computational requirements involved in evaluating policy recommendations created by the players during the course of a game. In educational games, all of the options or choices available to the players can be designated by the control team prior to the game. Little analysis needs to be done during the game. In games intended for identifying issues, the questions are more qualitative in nature and little to no analysis is called for.

Because its inter-move duration is long, an extended game can be used to formulate and evaluate policy options. In addition, the game is more focused on a single specific issue and on one path. The scope of other formats is too broad for them to be used in this way. The attention of the players is purposefully distracted away from one, major issue. This feature is valuable for some applications, but

| Purpose | Strength | Weakness |
| --- | --- | --- |
| Education | Expose small group to issues related to very complex issue | Extremely expensive to play game, time commitment too large |
| Issue Identification | Possibly locate obstacles to implementing policy recommendations | Format too structured to permit wide-ranging discussions |
| Policy Recommendation | Detailed analysis in game permits players to make good policy recommendations | Players may not use inter-move breaks effectively |

Figure 20.   Strengths and weaknesses of extended games.

is a serious drawback for the formulation of concrete options.

Finally, the long interval between moves gives the players the time to digest the material presented to them and the game's discussions. In the other formats the play is too rushed for the participants to have adequate time to think or to discuss any point raised by one player more than super-ficially. The pace must be brisk in order for the game's demanding schedule to be maintained. The extended game moves at a slower rate, and the players can be encouraged to evaluate issues in detail. In this way they are better prepared to make more concrete proposals.

## 7.4  WEAKNESSES.

Because the extended game format is designed for the formulation of policy recommendations, it is not well suited for other purposes. For example, it has limited utility for education for the simple reason that it requires a very large time commitment from the players compared to the other formats. In addition, extended games work better if most of the players are more experienced in path gaming, and thus the game can be used to educate only a fraction of the players. The mini-game format suffers from the same limitation, except that since it requires a very small time commitment this limitation is not a serious one.

The narrow focus of the game, while advantageous for concentrating the players' energy on a specific problem, makes its less likely that it can be used to identify previously unrecognized issues. In fact, the control team should purposefully discourage the players from digressing from fulfilling their specific charge, i.e., solving the precise problems given to them. The pre-game analysis, which could include other path games, should be used for this purpose.

As noted several times above, for this format to work properly both the control team and the players must spend time between moves analyzing the game and preparing for the next move. Experience with this format has shown that frequently this is not done. Players have many other responsibilities and may be unable to spend the required time on the game. The members of the control team must be able to devote most if not all of the inter-move break on analyzing the data produced in the game. Strict supervision of such a large group of people, who themselves work in a wide range of organizations, is not a feasible solution to this problem. Consequently, this form of gaming is less practical than it might appear.

# SECTION 8

## METHOD OF SELECTING GAMING FORMATS

The purpose of this chapter is to help guide potential sponsors and developers of path games in determining the most appropriate format to be used in their particular application. First, the most important inputs will be considered: the purpose of the game itself, the type of topic being addressed (which could be either narrow and well-focused or broad and ill-defined), and the level of resources available for the game (including the total amount of time to be used in the study). Next, the trade-offs that must be taken into account will be discussed since frequently no one single format will satisfy all of the goals of the game's sponsors or developers. Finally, some general recommendations will be offered, noting however that no "hard-and-fast" rules can be made for selecting the optimal gaming format.

### 8.1 INPUTS INTO THE SELECTION PROCESS.

As discussed above in Section 2, path games can serve three basic purposes. They can be used to educate the players in the complexities of a given policy question or new methods of addressing a given question. They can also be used to expose and then familiarize the players with gaming techniques in order to create a pool of experienced players for use in future efforts. Alternatively games can be

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intended for more concrete purposes: identifying previously unrecognized aspects of current policy problems or formulating possible solutions to overcome obstacles.

All games will contain an element of each, but before actually selecting a gaming format the game's sponsors should carefully consider the relative priorities which they attach to each. The chapters on each individual gaming format clearly indicated that each format is best suited to primarily one purpose, and less useful for other applications. Consequently, this step is the most critical one in deciding on the most appropriate format.

A second major input is the type of topic being addressed by the game. The specific problem (e.g., S.D.I., modernization of strategic offensive forces, or NATO's conventional force modernization) is not as important and the scope being addressed. For example, the scope can be extremely broad to include both political and economic variables or narrow to incorporate essentially only military, technical and budgetary factors. The broader the scope, the less well-defined its boundaries become. In this case, the path games could be played in order to understand better the parameters of the problem or to broaden the horizons of many of the policy makers and staff officials directly or indirectly involved with the problem. On the other hand, if the problem is well focused, then the types of questions which are to be considered are qualitatively different. For

instance, rather than bringing seemingly tangential variables into consideration to assess their impact on a given question, the key issues will center around a detailed evaluation of a set of fairly well known parameters.

The third important input which should be considered is the amount of resources available both for planning and playing the game or games and for evaluating the results. Although the level of funds which can be spent places obvious constraints on the kinds and number of games that can be played, the translation of these constraints into specific monetary amounts is non-trivial, and this report has purposely avoided citing costs in specific monetary terms. Many of the expenses are difficult to quantify. For example, the cost of using outside consultants will depend on their individual consulting fees, travel expenses, and any other associated costs. The cost of using government owned gaming centers would be irrelevant for path gaming in private industry, as would the cost of renting a conference center for a government sponsor, who might require secure facilities. Consequently, available resources will be discussed not in absolute amounts, but rather in terms of relative cost-effectiveness.

One resource that can be discussed in more concrete terms is time. The sponsor of a game or a series of games may have a limited amount of time during which to plan, execute, and evaluate the output from a path game. This

constraint can place severe limits on the kinds of games that can be used, especially if a series of games is to be played. It should be emphasized that, while many of the games themselves take only a few days to play, much preparation is necessary in order for these free-form games to be well organized and thus produce useful outputs. Even mini-games, which on the surface require little direct preparation, can be initially time consuming because in order for them to be effective a pool of experienced players must first be established.

## 8.2 TRADE-OFFS.

Before actually deciding on the gaming format to be used in a given application, it is essential that the game's sponsors and developers consider several important trade-offs. No one format will maximize all parameters. The three trade-offs discussed below involve the relative priorities attached to each purpose for the game (e.g., education of the players, identification of issues, and formulation of recommendations), the continuity of play as measured by the length of the inter-move duration, and finally the problem of cost-effectiveness.

When considering which of the three major purposes of a path game is the most important one for a given application, the implications arising from a choice of a gaming format should be carefully examined. For example, if the primary

purpose of the game is education, then it is likely that many of the players will be new to path gaming and possibly even to many of the details of the game's topic. This requires that the pace of the game be kept relatively slow at least initially in order to allow the players to become familiar with gaming techniques. On the other hand, if the game is intended to produce more tangible outputs, then more experienced players will have to be used so that the "warm-up" time needed by novice players can be avoided and more time devoted to the subject matter.

Furthermore, the length of both the moves themselves and the inter-move duration must be longer if the purpose of the game is to generate output rather than education. In the former case, the players will need more time during each move because they are being asked to do more and in more detail than in the latter case. A longer inter-move duration may be needed in order to provide more analysis for the players to aid them in making their decisions during each move. In the case of education, the length of both moves and inter-move durations should be kept to a minimum in order to increase the impact of the gaming technique on them and to minimize the need for constantly re-briefing them on past moves.

The implications of these trade-offs can be seen by a simple, hypothetical example. The primary purpose of the game is to identify the main issues surrounding a policy question of current concern, and the outputs are to be used

in subsequent analyses. In addition, the game is intended to expose some officials to gaming techniques and convince them of the utility of path gaming. In this case some of the players will be novices, and thus the limitations related to inexperienced players discussed above apply. The inter-move duration would have to be long enough to allow for the necessary inter-move analysis, but not so long as to disrupt the flow of the game. The length of each move must likewise be long enough for the players to fulfill their charges, but at the same time geared to the level of the players (i.e., accommodating the number of novice players).

The result of these considerations indicate that a mini-game format is possible only if the number of new players is relatively small and a pool of experienced players already exists. In fact, a mini-game is a good device for these purposes (e.g., issue identification and exposure to gaming techniques) once a sufficiently large pool of players has been established, and this is a good reason for creating such a resource. On the other hand, if these conditions are not met, then a one-day game would be a more reasonable alternative. This format relaxes the time constraints of a mini-game and allows the use of more inexperienced players.

Another key trade-off involves the impact of each format on the continuity of play in the game. One distinguishing feature of each format is the length of the inter-move duration; the longer this break between moves is, the more

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play will be disrupted. However, there are both advantages and disadvantages to long and short breaks. Depending on the level of resources available, the purpose and topic of the game, and the kinds of players to be used, some of the advantages could make a format extremely attractive. Alternatively, the disadvantages could render a format totally impractical.

A long inter-move duration of a day (i.e., multi-day game) or several weeks (i.e., extended game) is valuable because it allows more time for detailed analysis and the preparation of new briefing materials for each move. The players will have more time to reflect on the discussion of previous moves and to digest the material presented to them. The drawbacks of this prolonged break include the need to re-brief the players on the results of prior moves and the resulting changes in the strategic environment, a process which consumes valuable time. Long breaks can also result in player turnover because not all participants will be able to attend each subsequent meeting. Finally, there is a limit to the amount of new, quantitative analysis that the players can absorb and thus use during the course of a move. Not all of the analysis performed during the break can be used.

A short inter-move duration of several hours (i.e., one-day game) or less (i.e., mini-game) also has several important benefits: the player turnover should be low; the players, once put into the strategic environment of the g e

and kept there, are more likely to accept its implications; there is little need to spend time re-briefing the players during the game. At the same time, the control team will not have time to perform any quantitative analysis or prepare detailed charges and new scenarios. This limitation will make it difficult for time scale of each move to be long. In other words, the "game clock" can not be advanced very far after each move because the control team will not be able to provide an adequate description of a future strategic environment.

For applications where detailed analysis is essential because the scale of each move is long or the topic requires quantitative analysis and player turnover can either be expected to be small or adequately controlled, the longer inter-move durations are possible. In practice, these conditions will be met only if the boundaries of the problem being gamed are relatively well understood and are not themselves the issue under investigation. If inter-move analysis is not essential or if the amount of resources available for the game do not permit the use of more involved formats, then the inter-move duration should be minimized. Game topics where the problems are ill-defined and the game is to be used for preliminary or exploratory analysis fall into this category.

The final major trade-off involves cost-effectiveness. One cannot merely choose the game format that maximizes the

utility of the game for the problem at hand. Consideration
must be given to the marginal improvements made possible with
each format in light of the resulting increase in costs. The
costs can frequently be intangible and difficult to quantify,
as the two examples discussed below indicate.

Some gaming formats take more time not only to play but
also to prepare. The amount of preparation time, while it
may increase the cost of the game in purely monetary terms,
allows for the more optimal use of the scarce time of senior
decision-makers. The unstructured nature of path gaming can
reduce a game for which adequate groundwork was not laid into
an exercise in futility. The players can easily be
distracted into discussions on tangential issues and become
confused as to their function and purpose. The more time and
effort spent on preparations, the smoother the game will flow
and the less time will be wasted. In this instance, the cost
is measured by the efficiency with which time is used.

A multi-day game may frequently appear in theory to be
the optimal format for a given application, especially those
involving complex issues. However, these games are also
expensive and cumbersome in practice. A series of mini-games
can prove to be a more cost-effective solution, even if they
do not produce the same level of output possible with a
multi-day game. One means of approaching the use of mini-
games is to have each game evaluate a different aspect of the
problem, rather than taking on the entire problem in a single

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multi-day game.  This approach may help make the problem more
manageable.


8.3  GENERAL RECOMMENDATIONS.

The problem of selecting the most appropriate gaming
format is a difficult one.  No hard, rigid rules for deter-
mining the best format for a given application exist.  Some
general guidelines will be offered in this section in order
to aid the developers and sponsors of path games in matching
their needs to a reasonable gaming format.  These recommenda-
tions are summarized in Figures 21 through 23 below and are
grouped according to the inputs discussed in section 8.1
above.  In each chart the suggested format is highlighted.

A one-day game will frequently prove to be a useful
format for educating a large number of people and familiariz-
ing them with gaming methods.  (See Figure 21.)  A multi-day
game can also be used, but it involves a considerably larger
time commitment by the players without guaranteeing a
correspondingly larger payoff -- unless the game's topic is
an extremely complex one.  Mini-games and extended games are
useful for education but only if the intended audience is
small.  The total number of players in a mini-game is small
(i.e., approximately one dozen) and many of them must be
experienced players given this format's severe time con-
straints.  Consequently no more than a handful of new players
can be accommodated.  However, within these limitations a

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| | Education | Specific Recommendation | Issue Identification |
|---|---|---|---|
| Mini-Game | Good for small group of players | Possible | *Very Good* |
| One-Day Game | *Very Good* | Unlikely | Possible |
| Multi-Day Game | Good | Possible | Possible |
| Extended Game | Good for small group of players | *Good* | Unlikely |

Figure 21.  Recommended gaming format depending on purpose.

|  | Broad<br>Ill Defined | Narrow<br>Well Focused |
|---|---|---|
| Mini-Game | *Very Good* | Good |
| One-Day Game | *Very Good* | Good |
| Multi-Day Game | Good | Good |
| Extended Game | Poor | *Very Good* |

Figure 22. Recommended gaming format depending on game topic.

|                  | Short<br>( 3 mo.) | Medium<br>(6 mo. – 1 yr.) | Long<br>( 1 yr.) |
|------------------|-------------------|---------------------------|------------------|
| Mini–Game        | *Good*            | *Very Good*               | *Very Good*      |
| One–Day Game     | Possible          | *Good*                    | *Very Good*      |
| Multi–Day Game   | Poor              | Possible                  | *Very Good*      |
| Extended Game    | Poor              | Possible                  | *Very Good*      |

Figure 23. Recommended gaming format depending on period of performance.

mini-game is an excellent device for introducing decision-makers to the benefits of gaming, while also exposing them to wide variety of issues and points of view. Extended games suffer from similar problems but for different reasons: the extremely large time commitment and the level of detail involved limit its utility in education.

If the primary purpose of the game is to help formulate policy recommendations, then, as indicated in Figure 21, the extended game format is good alternative. The remaining formats cannot easily handle the amount of analysis required in helping to formulate specific recommendations. These format may be useful in helping to identify potential obstacles or problems, but less helpful in possible solutions. It is possible that the broad outline of possible strategic policies could be suggested.

The main strength of the mini-game format is its ability to help identify issues related to a given policy problem that had gone unnoticed. If this is the basic purpose of playing a path game, then a single or, more likely, a series of mini-games is probably the best alternative. A one-day game could also be used for this purpose, but since it is restricted to investigating a single path, its ability to identify issues is similarly limited. Multi-day games suffer from the same problems as one-day games. Extended games, due to their narrow focus are ill-suited for this purpose.

As indicated in Figure 22, both mini-games and one-day games are useful vehicles for investigating issues which are broad in scope with ill-defined boundaries. These formats are sufficiently unstructured to allow the players the ability to reformulate the main questions posed at the beginning of the game. A multi-day game, because it is a more cumbersome format, cannot be used as flexibly, but it is still well suited for accommodating broad, wide ranging topics While their structured nature makes them less appropriate for ill defined problems, extended games are best adapted for narrow and well focused topics. Any of the other formats can likewise be used if the problem is well defined.

Since, as noted above, many of the monetary costs associated with a path game cannot be readily measured, one means of assessing the cost-effectiveness is to use the period of performance for the game, or the total amount of time required for the conceptualization, preparation, execution, and analysis of the game. Figure 23 distinguishes three levels: (1) quick reaction analyses requiring 3 months or less; (2) more involved studies taking from 6 months up to a year; and (3) long-term analyses which last for a year or more.

If the game's sponsors have approximately 3 months for the path game, then the only format that is reasonable to consider is the mini-game, especially if a pool of experienced players already exists. As the length of time

increases to over 6 months, then one or more series of mini-games can be played or a one-day game can be considered. While it is possible to prepare a single one-day game in 3 months, more time may be needed for both pre- and post-game analysis, or for the use of either a set of one-day games or a combination of mini-games and a one-day game. As the total period of performance approaches a year or more, any of the gaming format can be used to analyze a given policy problem. Both extended and multi-day games, because they rely on specially developed computer software for in-game analysis, require more extensive pre- and post-game analysis.

It should be noted that any gaming format can be fit into nearly any length of time. But a price would have to be paid in the form of inadequate preparations (e.g., some players, especially team leaders, not being fully briefed on gaming techniques) or incomplete post-game evaluations of both the substantial conclusions reached during the game and the methodological difficulties encountered -- and the proposed solutions to these problems. The guidelines shown in Figure 23 are thus the preferred ones for the optimal use of path gaming.

# APPENDIX A

## GLOSSARY OF GAMING TERMS

**Blue Team:** This team represents the main actors in the game. Typically in a path game the U.S. is represented by the blue team, but frequently this team may represent only the Department of Defense or the executive branch of the federal government. The Congress or the public may be represented by the "green team."

**Branch Variable:** A major variable which separates two individual paths is a branch variable. Either the players themselves or the control team determines the value of the branch variable. Examples of a branch variables are the presidential elections and the negotiation of arms control agreements.

**CADS:** See Computer Aided Decision Simulation.

**Charge To Players:** The set of questions and issues which each player in a path game is expected to address is called their charge. The. game's developers create the charge for each player, and the control team and each team's leader is responsible for insuring that the charge is fulfilled.

**Closed Play:** Games in which each team meets separately and all communication among them occurs through the control team are referred to as "closed." The teams may meet in a plenary session at the end of each move, but all interactions are still monitored by the control team. See also "open play."

**Computer Aided Decision Simulation (CADS):** This is a form of path game which utilizes computers to display game material and monitor game results. This style of gaming is also referred to as a "mini-game."

**Control Team:** The control team is responsible for monitoring the game, providing the charge to the players, monitoring communications, establishing any changes in the strategic environment for each new move (e.g., changes in influence and branch variables), maintaining a record of the game, and providing the necessary administrative support.

**Crisis Game:** A politico-military simulation which models an international crisis and especially the decisions surrounding the events leading up to a possible superpower confrontation is a crisis game. The scope of a crisis game is considerably broader than that of a war game since it involves foreign policy in addition to purely military considerations.

**Decision Point:** In a path diagram, a decision point is where a major decision regarding a branch variable must be made. The players determine the path to be followed.

**Developers Of Path Game:** The individuals or organizations responsible for sponsoring the game and determining its main topic are referred to as the developers. Frequently, the developers do not participate in a game as players, although they may be members of the control team.

**Environmental Variable:** These are variables which affect the politico-military environment within which players in a path game must make strategic decisions. Examples of environmental variables are the status of the U.S. economy and the federal budget deficit, the overall make-up of the Congress, and the impact of international crises.

**Extended Game:** A path game format in which the inter-move duration is one week or more and the move duration is usually one-half day is an extended game. This long break between moves allows the control team to analyze the previous move in detail and develop a new charge for the players, and it gives the players more time to think over the game materials. In this format more quantitative data (e.g., budgetary data) can be provided to the players than is possible in other gaming formats.

**Format:** The basic structure of a path game is defined as a format. The various formats are distinguished by the move duration, inter-move duration, game length, number of moves, number and kinds of teams, style of play (open or closed), and the number and kinds of players. There are four path gaming formats: (1) mini-games, (2) one-day games, (3) multi-day games, and (4) extended games.

**Game Time:** The rate at which time moves for the purposes of a game is the game time. In path gaming, game time is greatly compressed compared to "real time" because over the course of a few hours of real time the game may cover several years of simulated time. In other forms of gaming, game time could be considerably slower than real time.

**Green Team:** The actors which influence the blue team's actions but do not directly compete with it are included in the green team. Groups and organizations which can influence U.S. decision-making but which are not included in the "blue team" are included in a green team. These interests can encompass the concerns of the NATO allies, Western or American public opinion, the news media, U.S. Congress, and the view points of the so-called "strategic thinkers" found in academic institutions and consulting firms.

**Influence Variable:**  These variables do not determine the direction that a future path will take, but do affect the magnitude of the impact of a branch variable.  In other words, if an influence variable takes on a certain value, then the decisions associated with a branch variable could become more or less critical.  Examples of influence variables are internal DoD politics, the House and Senate Armed Services Committees, and in certain cases the NATO allies (i.e., where the topic of the game is not directly related to NATO).

**Inter-move Duration:**  The amount of "real time" separating consecutive moves in a game is the inter-move duration.  This time is used by the "control team" to analyze the results of the previous move and prepare the new charge to the players for the next move.  In addition, the players themselves can take advantage of these breaks to digest the game materials and prepare for the decisions to be made in the next move.

**Mini-game:**  A form of path game in which the move duration is approximately one hour and moves are consecutive (i.e., the inter-move duration is essentially zero) is a mini-game.  The total length of the game is one-half day, or four hours.  Typically, only two teams are used in a mini-game: a "blue team" and a "control team."  Given the extensive use of

computers in order to facilitate the game play, this format is also called "Computer Aided Decision Simulation."

**Move:** A game consists of one or more moves during which the players make decisions and perform actions in order to accomplish their stated goals. In a move, the players may be required to answer a set of questions, conclude negotiations, deploy military forces, or determine the outcome of a armed conflict.

**Move Duration:** The amount of real time which each move lasts is the move duration. The duration of a move can vary from one hour to a half day.

**Move Scale:** The amount of "game time" covered in each move is the move scale. In path games, the move scale is between one and five years.

**Multi-day Game:** A form of path gaming in which the move duration is one half day and the inter-move duration is one day is referred to as a multi-day game. Moves are played on consecutive mornings, with the "control team" using the remainder of the day to analyze the results of the morning's move and to prepare for the next day's move. Since a path game usually has three moves, a multi-day game lasts for three consecutive days. Unlike mini-games, a multi-day game

consists of between three and four teams: "blue," "red," "green," and "control" teams.

**One-day Game:** A variant of path game which lasts an entire day with a move duration of one to two hours and an inter-move duration of up to one hour is referred to as a one-day game. Like multi-day games, a one day game will usually include several separate teams.

**Open Play:** If all the players of the various teams in a game meet together and are permitted to interact freely without the direct involvement of the "control" team, the game play is called open. Some formats for path games are inherently open (e.g., mini-games or CADS), while others could be either open or "closed" (e.g., one or multi-day games).

**Path:** The set of decisions which connect the current strategic environment with a possible future environment is called a path.

**Path Diagram:** A flow chart which outlines the major "decisions points" and the impact of "branch variables" on the course of events connecting the current strategic environment with possible future environments is referred to as a path diagram. This chart is used by the developers of a path game

as a rough road map when identifying the major actors and writing the "scenario" for a game.

**Path Game:** Path gaming is a specific gaming technique which employs an unstructured, free style game to investigate long range planning problems with the main purpose of examining the future implications of present-day decisions by greatly reducing the normal time lag between a decision and its consequences.

**Real Time:** To distinguish actual time from the fictitious "game" time, the former is called "real" time. For example, the duration of a move may be one hour while the game may cover several years as measured in game time.

**Red Team:** The blue team's main competition or the major actors to which the blue team must react are included in the red team. The Soviet Union and the Eastern bloc in general is represented by the red team in a path game. Path games may not explicitly include a red team, if the major issue under investigation centers around internal U.S. politics. Otherwise, the red team will be used to react to the blue team's initiatives and to provide simulated Soviet initiatives.

**Scenario:** A scenario is the written account of the situation under which a game is to take place. In path games, it will identify the "paths" which the players are to investigate, describe the "environmental variables," identify the major actors involved in the game, and provide any quantitative data which the players may need in the course of the game (e.g., force levels, budgetary data, etc.).

**War Game:** A war game models an actual military engagement and involves mainly military considerations. Broader foreign policy issues are not included.

## APPENDIX B

## SUMMARY OF PATH GAMES

This appendix contains a brief summary of some of the path games played on the general topic of national security policy over the past several years. Several of these games were conducted under the sponsorship of this contract. The purpose of this appendix is to provide some concrete examples of actual path games.

The first chart (see Table B-1) shows an overall listing of the games, their topic, when each was played, and the format used. The mini-game format dominates the more recent games because, as indicated in the main text of this report, this format was shown to be a very flexible and cost-effective format. The second chart (see Table B-2) summarizes the gaming techniques used in each game: the kinds of moves and the style of play. The last chart (Table B-3) displays the number and types of players in each game and the support required.

Two of the games listed in these charts employed some novel techniques which were not discussed in the main text of this report. The games on nuclear test limitations and U.S.-Soviet military competition both used two blue teams and the latter also had two red teams. The purpose of this innovation was to provide different perspectives for the blue

team; allowing in effect different paths to be explored in the same game. In the second case, one blue team was used to represent the views of a conservative administration, regarding U.S.-Soviet competition. This team created a new base line for both itself and the second blue team for move two. This allowed the game to examine a much wider range of perspectives than would be possible using more traditional gaming techniques.

Table B-1.   Summary of Path Games.

| Game | Date | Topic | Format |
|------|------|-------|--------|
| SDI | May 1984 | Long-Range SDI Planning and Programmatic Trade-Offs | One-Day |
| NATO Defense Initiative | Oct. 1985 | NATO Defense Initiative and Alliance Strategy to 21st Century | Multi-Day Game |
| TNF & ATBM | Jan. 1986 | Examine Increased Reliance On Active Defense Versus TNF | Multi-Day Game |
| SDI Deployment | Aug. 1986 | Explore Paths Toward Deployment of SDI Based on Budgetary Allocations | Multi-Day Game |
| SDI Transition | Jan. 1987 | Examine Political Obstacles Hindering Transition to SDI Deployment | Mini-Game |
| Nuclear Test Limitations | Feb. 1987 | Examine Various Paths Toward Test Limits and Expose Compliance Problems | Extended Game |
| ABM Treaty Interpretation | March 1987 | Investigate Implications of ABMT Interpretation for SDI | Mini-Game |
| Political Stability of SDI | March 1987 | Study the Long-Term Political Stability of SDI Program and Arms Control | Mini-Game |
| U.S.-Soviet Military Competition | May 1987 | Study Preferred Direction in U.S.-Soviet Competition Over 20 Years from Both U.S.-Soviet Perspectives | Extended Game |
| Insti-tutionalizing SDI - Game 1 | June 1987 | Study Institutionalized Support for SDIO and Possible Re-organization | Mini-Game |
| Insti-tutionalizing SDI - Game 2 | July 1987 | Study Institutional Support for SDIO and Possible Re-organization | Mini-Game |

APPENDIX C

HANDBOOK FOR THE DEVELOPMENT OF

COMPUTER-AIDED DECISION SIMULATIONS

C.1  THE SETTING.

The political-military simulation, or gaming, is a national security research tool.  It is used to develop insights into situations where the interaction, moves and counter-moves of participants with opposing goals (representing countries, forces, factions or opposing interest groups) determine the outcome.  The term "gaming" includes any type of simulation in which the flow of events is affected by decisions made by players representing opposing sides or viewpoints.  Such games, or simulations, are most effective when used to investigate processes, and to gain insights, not to calculate outcomes.  While the techniques of various games can share many similarities with other analytical tools -- detection modeling, attrition modeling, and so on -- gaming is unique in its ability to show how uncertainty and human decisions affect the course of events.  As a tool of analysis, it has recently acquired the sort of intellectual enthusiasm accorded to systems analysis in the 1960s.  The basic reason has been the data processing speed and the versatility of the Personal Computer (PC), which enables games to be run quickly and efficiently, at a fraction of the manpower and dollar costs previously required.

Gaming is a mechanism to examine issues. It cannot predict outcomes; it can and should illuminate the process and dominant variables which cause outcomes. In other words, it should cue a decision-maker about which factors and factions deserve special attention and care.

Gaming is most useful where the results are driven by competition, by the power of competing interest groups or nations, by situations where power, not logic or analysis, will decide the outcome.

C.2  DNA REQUIREMENT.

On 4 May 1984, the Defense Nuclear Agency sponsored an experimental simulation at the war-gaming center of the Naval War College in Newport, Rhode Island. The purpose was to determine whether gaming could illuminate the long-term (ten to 20 years) consequences of near-term procurement decisions concerning strategic systems. The subject matter DNA chose for the game was strategic defense. As the participants made procurement decisions in blocks of time (1984, 1985-90, 1990-95, etc.), they were, in essence, creating a path, or a stream of decisions into the future.

Since then, DNA and the SDIO have sponsored several variants of the "path game" concept. In September 1986, HRA was put under contract by DNA to conduct several such games in order to determine whether the methods being developed had utility. HRA selected GAMA as the subcontractor responsible for developing the unclassified gaming methodology. This

short handbook explains the method, now called CADS, or Computer-Aided Decisions Simulation, as it has evolved through successive iterations.

C.3 THE CADS MODEL.

During the course of this research effort, the GAMA (Gaming and Analysis) Corporation has modified several gaming techniques to fit the specific requirements of DNA and SDIO. The basic approach was to gather a group of gaming and substantive experts familiar with the gaming style GAMA used in other contexts and walk through the material DNA wanted to see addressed, repeating the process several times, identifying the set of independent variables which emerged as most influential, and gradually developing an approach which could be duplicated. A detailed description of the actual runs was submitted to DNA to March of 1987 and is on file with DNA as a "For Official Use Only" document. Nine methodological games were held in 1986 and four in 1987. From these thirteen trial runs, the following basic model was developed. It has six steps.

C.3.1 ISSUE IDENTIFICATION.

To do this, the game designer must meet with the client (the game's sponsor) and listen to his explanation of the problem or the issue he wants gamed. The game's developer then has the responsibility to pull together a small group of analysts some of whom have substantive knowledge of the issue

and some of whom are gaming experts. In a give-and-take
session, they seek to transform the client's issue into
specific terms which can be gamed, paying particular but not
exclusive attention to what the client believes are the most
serious variables which will drive the outcome. The game
developer then presents to the sponsor a description of the
game focus.

## C.3.2 SCENARIO/CHARGE TO THE PLAYERS.

The next step is to write: a) the set of baseline data
the players need to know in order to participate
intelligently; b) the starting scenario which translates the
sponsor's issue into a subject with enough specificity to
game; and, c) a charge to the players, often divided
according to the team assignments. The charge serves as the
prism which organizes the discussions and recommendations of
the participants. Hence the charge(s) are a critical game
component and must be carefully crafted.

In terms of deliverables, for each game, there are six
tasks the contractor responsible for game method must
perform. The _first_ _task_ is to write the scenario.

The _second_ _task_ is to write the charge to the teams for
each move.

## C.3.3 PLAYER IDENTIFICATION/INVITATION.

The contractor or game developer next presents to the
sponsor a list of the people deemed appropriate, given the

subject matter. After approval, the contractor arranges for the participants, their travel, etc. The sponsor may choose to issue letters of invitation, or require that the contractor do so. As a rule of thumb, it is best to include a mix of experts from the various government agencies and from outside governments.

The optimum number of players in this type of game is between 10 and 16. The subject matter is carefully defined ahead of time and is specific; one is not trying to game a world at war or some other subject requiring a multitude of players and support equipment. It is important for group dynamics that each player have the opportunity to speak because presumably any invitee has something to contribute. Player interaction is difficult to achieve if there are more than 16 players at the table.

The _third_ _task_ for the contractor is to invite the players.


C.3.4  GAMING TECHNIQUES.

The subject matter should determine the technique applied. A game can either be closed or open. In the closed game, the teams are kept in separate rooms and move in accordance with data and instructions passed by Control. There is no direct interaction among the competing teams. The Joint Analysis Division of the Joint Staff has considerable experience in such games. GAMA is not inclined towards closed games; although they are easier for the

Control (contractor) Team to direct, they lack the insights which occur when the competing teams are able to confront each other.

The open game technique has several variants. At the Global War Games in Newport, Rhode Island, the international cells of Blue, Green and Orange negotiate face-to-face, and there is a daily general session at which Blue and Orange explain to the players their general concepts of operations.

GAMA uses two variants of that technique. The first centers around competing teams who decide in caucus what their moves will be. This is followed by a plenary session at which each team is asked to explain its preferred move and the calculus which led to it. Hence the players become the analysts. The second technique is to keep the players, each assigned a specific role, in plenary session and make each move by having each participant in turn respond to the charge. This puts a heavy burden on Control, and Control must work well with the chairman of the players. The advantage of the technique is that many points can be handled in a short time-frame, and one respondent can elaborate upon or correct or challenge the position of another.

In either case, the _fourth_ _task_ is to direct and control the game.

C.3.5  GAME PLAY.

There are four essential components.

1.  Duration.

The original geopolitical games were conducted as
standard war-games, requiring the attendance of the players
for at least one full day or more, or for several half-days
in one week.  This was changed because the vast majority of
participants had said all they could or wanted to say about a
subject in four hours.  This may seem self-evident; still,
most games are designed around the expectation that the
participants will devote full days to the simulation,
although they do not devote such time to any other subject on
their daily calendars.  Most of us have exhausted what we
have to say in four hours.  So the CADS (Computer-Aided
Decision Simulation) system limits the simulation to that
length of time.

In four hours, there usually is time for three moves.
Each move may consist of a 30-minute team caucus followed by
a 30-minute plenary session in which the teams exchange
information and perceptions of results.  Or, if the four-hour
plenary game technique is employed, then four one-hour moves
are possible.


2.  Focus.

It is a prime duty of Control to maintain a focus to the
game and to limit the tendency of the players to wander down
interesting by-paths.  In this effort Control is assisted by

the preciseness with which the charge to the players has been written, by the selection of and the coordination with the game chairman, (who is a game participant) and by the CADS system.

3.   Use of Computer Systems.

Computers are used in an unobtrusive but helpful fashion.  They assist in the provision of data, in providing the frame of reference, in recording in real time the decisions of the players, and in providing a record for post-game analysis.  The individual in charge of the computer input must work closely with Control prior to and during the game.  The system GAMA Corporation has gradually developed incorporates several pieces of software and hardware.  It permits Control to show the participants graphically the flow of the game and how one move relates to another.  These diagrams are adapted from the Gantt method and they enable the players to see at a glance how the particulars of the issue under immediate discussion relate to the overall purpose and direction of the game.

The computer is also used as a word processor.  A recorder works full-time to capture the essence of the logic and conclusions of each team.  This summary 'is displayed in real time; that is, when a player says something the recorder judges of key significance, it is immediately displayed on a large screen for all players to see and to correct.  Also, at the conclusion of each move, the leader of each team is asked

to summarize where his team stands, and that summary and the recorder's efforts are then reviewed by the players and corrections are made. Thus the role of the recorder is important and he must have the skill to listen to ten minutes of conversation and capture its essence in ten words. As a rule of thumb, each hour of player team interaction yields one screen of information with about ten separate points. The _fifth_ _task_ is to record the game in real time and to display the record to the participants.

In terms of hardware, a good combination in the main game room is a Compaq 386 linked to an RGB (red/green/blue) display projector. This allows the graphics -- which show the alternative paths the players are pursuing -- to be shown in different colors. By using a three-way switch, the record of the move can be shown simultaneous with the graphic, or one or the other can be turned off. Any Personal Computer (PC) can be used if it has 640 KB of memory and a hard disk. The _sixth_ _task_ is to take the record from the game and analyze the results and describe the insights gained.

4.    Control.

Control has several tasks to perform. He must design the game, provide the focus through the charges to the players, arrange for the right mix of players, attend to the pace of the game, interjecting directly or through the game chair, decide whether to elongate or truncate each move depending upon the players' deliberations, and insure that

the result is both pertinent and interesting to the
participants who have worked for four uninterrupted hours.

C.3.6  SERIES.

A game is not played to predict an outcome; it is played
to gain insight into the variables or events which may drive
or affect the outcome.  Obviously, a series of games is more
valuable than just one effort.  Each game can lead to
refinements and provide the building blocks for the next
effort.  This is analogous to the staff process.  The staff
system is designed to insure that the pertinent information
has been gathered and synthesized in order to allow the
decision-maker to deal with an issue in an efficient manner.

A series of games can be a staff action.  This can be
accomplished in three steps.  First, the sponsor identifies
the issue and the gaming experts work to frame the issue in
gaming terms.  If they have familiarity with the sponsor and
the subject matter, they may accomplish this one or two pre-
game brainstorming sessions.  They then hold a four-hour
"minigame" among themselves, placing the emphasis upon
process.  The intent is to clarify which variables and
interactions deserve to be highlighted in the scenario and if
the subject matter is particularly difficult, the gaming
staff will have to devote several sessions to the development
of the proper gaming framework.  For instance, in preparing
for one SDI game, GAMA conducted seven in-house minigames

before being satisfied that the game was ready for the SDIO staff to participate.

Second, after the gaming contractor has run his minigame(s) and has shaken down the process, the game is conducted at the staff level. The sponsor and other interested parties provide participants and the emphasis is upon the substance of the issue. At the conclusion of the game, the outcome focuses both upon substance and upon procedures which would strengthen the game process.

Third, the contractor makes the agreed-upon changes and the game is conducted again, this time with senior officials, many of whom have been preferred by their staff officers who participated in the prior game. Hence the game is conducted along the lines of a staff action, with more thought and care than is generally possible.

C.4   SUMMARY.

The CADS game model, as it has been developed since May of 1984, has these distinguishing features:  it is short in terms of time; it is iterative; it uses computers unobtrusively both to provide data and focus, and to keep the record; it is small, using between 10 and 16 players; it is structured; it is free play; it can be repeated rapidly and requires little or no support.

C.5  PROGRESS IN METHODOLOGY.

The DNA and SDIO sponsorship has had as a focus the development of a method of gaming. The question, then is where the method stands today as compared with the first path game conducted in Newport three years ago. The following is a summary of the changes which have occurred.

--    The original game required senior officials to devote a day and a half, including travel time. The pre-game briefs took two hours, the game ran for eight hours and the final debriefing for one hour.

The CADS game takes four hours of a senior executive's time.

--    The original concept envisioned one stand-alone game.

The CADS game is a serious of three mini-games. It includes a staff game and a decision-maker game.

--    The original game tried to follow one path into the future.

The CADS game permits multiple paths to be tested.

--    The original game left the moves unstructured.

The CADS game has a move structure and a graphic display which permits the participants to associate one move with the next.

-- The original game left it to the participants to develop a focus to their efforts.

The CADS game provides a charge to the players which focuses each move. The players may override the charge, if they choose.

-- The original game tried to advance from the present to a desired future point.

The CADS game has developed several alternative techniques, including starting from the desired end state and working a path backward to the present, identifying the critical conditions which must be satisfied if the future goal is to be attained.

-- Information in the original game was provided in book form and rarely referred to by the players.

The CADS system allows information to be stored and displayed during the game when it is relevant to the discussion.

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--      The original game had to employ time steps,
        or leaps, of five to ten years.

The CADS system requires the game designers to move
progressively through time, not to leap ahead.  Once the
designers have done this, they can identify the variables
which are most critical and the actual game players can then
take time steps based on the research which has been done.

--      The original game relied upon a verbal
        debriefing and summary of each move.

The CADS system records each move and the debriefing.

--      A blackboard was used in the original game to
        keep track of the moves and of the key points.

The CADS system makes integral use of the power of PCs.

--      A large support staff was required at the
        original game because so many functions
        were manual.

The CADS system allows for a lean contractor support team of two to four people.

-- The original game, with its large supporting cast, was rather expensive.

The CADS game is inexpensive.

Table C-1 compares the current CADS system to the original effort.

C.6 VALUE ADDED.

Since gaming is a tool of analysis, what is the value the technique described above -- called CADS -- adds to an understanding of nuclear issues?

-- CADS yields insights, especially when the teams are shuffled in order to include experienced outsiders (such as former officials) who do not have a vested personal or institutional position on the issue. Gaming does not predict outcomes.

-- CADS provides a check on conventional wisdom. Often a theory or a position on a subject may sound reasonable, but serious gaps in the logic or the implementation are revealed in the

Table C-1.    Development Of The CADS (Computer-Aided
              Decision Simulation).


May 1984 Effort                 November 1987 Model

8-11 hours per game             4 hours
participants' time required

One game stood alone            Three game series

No staff input                  High staff participation

One future path could be        Multiple Paths
tested

Moves unstructured              Moves structured and displayed
                                via PC

Participants determined         Specific charges given
focus

Game advanced from present      Several alternative techniques
to future goal                  used, some working from the
                                future back

Information given in books      CADS stores and presents data
not read                        during game play

Time steps were actually        Homework done before any step
leaps

Verbal summary                  CADS records each move and the
                                summary

Key points written on           CADS insures a complete record
blackboard

Manual functions required       Lean support team
large staff

Expensive                       Inexpensive

Intuitive                       Allows a staffed package

process of gaming against equally intelligent participants with different points of view.

-- CADS makes explicit the reasoning and th points of leverage which together determir the success or failure of most programs, but which are rarely addressed in the same meeting.

-- CADS involves the staff as part of the solution, not as the gatherers and transmittors of information. The staffs work through the problem and do not just array alternatives for their superiors. Later, as good staffers, (and we are all staff to someone above us) they may present the issue up the chain in terms of options and pros and cons. But the point is they have worked through the logic themselves, both learning and contributing to the body of knowledge about the issue.

-- CADS is a mechanism for identifying the critical variables which will most seriously affect the outcome.

-- Most importantly, CADS is a means of acquiring informed judgment about complex subjects in a structured manner and in a short peri d of

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time.  CADS has three steps.  First, the game
designers run a game to smooth out the process.
Then the cognizant staff participates.  Lastly,
the senior decision-makers, with the input
from their staffs, participate.  Hence a
complete staffing procedure can be accomplished
within the context of a game series, or the
game can be commissioned as an inexpensive
alternative source of information and expert
opinion on a complex subject.

APPENDIX D

MULTIPLE ATTRIBUTE DECISION THEORY

D.1   INTRODUCTION.

The environment with which participants in a PATH Game
must contend is a complex one involving many interrelated but
widely disparate variables.   Not only must the technical
capabilities of future weapon systems be considered, but also
budgetary constraints and political realities, both domestic
and foreign, must be taken into account.   Within the context
of a PATH Game, the players must bear all of these
considerations in mind when formulating their proposed moves.
In order to simplify this process a technique known as
"Multiple Attribute Decision Theory" (MADT) was proposed.   It
was incorporated into a series of computer programs which are
described below, along with some applications and an
assessment of their utility in PATH Gaming.

The primary value of MADT is its ability to combine
together into a single index, or Figure of Merit (FOM),
variables of widely varying character.   In other words, it
provides a framework which permits an analyst to "mix apples
and oranges."   This is a process which all decision-makers
must address at least implicitly.   MADT attempts to make this
process more explicit and thus more transparent and
understandable.   For example, MADT allows scores to be
assigned to such variables as the public reaction to a
proposed weapon system, its direct costs, and its military

capabilities. These variables, when placed within a "tree-like" structure which schematically indicates the interrelations and when provided with relative weights indicating their importance to the decision-maker, can be combined into a single figure of merit. A large figure of merit indicates that the proposed policies and/or weapon systems are both advantageous and consistent with the decision-makers expressed preferences.

This technique has been incorporated into a series of computer programs which can be used during the course of a path game in order to aid the players in evaluating the consequences of their moves. These programs are an example of how the control team can use computers to aid players during the course of a path game. The running time of these programs is sufficiently short for them to be used in nearly real-time. The outputs can be used at two points in the game: 1) during a move players can request quick assessments of various options in order to understand the effects on military, economic, or political variables; and 2) following each move a more detailed analysis of the consequences of a move can be presented. This analysis should help the players, for example, in better evaluating the reactions of the American public and of the U.S. allies because these reactions are explicitly incorporated into the MADT structure.

In addition, MADT can be used to perform more detailed, post-game analysis.

D.2   METHODOLOGY.

A MADT computer-based interactive code has been
implemented to address complex problems involving "mixing
apples and oranges."  The methodology used to construct a
decision tree, assign weights and scores to the variables in
that tree, and compute the figures of merit is described
below.  For use in PATH Gaming, the structure of the tree is
defined prior to the game and values must be provided for the
weights because this process is too time-consuming to be
accomplished during the course of an actual game, especially
a mini-game.

The top-most level of the decision tree, labelled as
Level 0, contains the calculated figure of merit (FOM) for
the entire tree configuration that is under consideration.
(See Figure D-1.)  In order to begin the process that
calculates the FOM, an analyst first describes the problem in
terms of his most important (Level 1) goals and preferences,
thus assuring that the information is in terms that are
clearly comprehensible to him.  At the highest levels ot the
structured decision tree the more abstract aspects of the
problem are addressed which is perhaps best accomplished in
close harmony with, for example, the sponsor of the game.
These primary considerations are then weighted, each
according to their relative importance.

For the sake of simplicity, weights are assigned values
as ratios.  In other words, if one variable is seen as twice
as important as another variable, then the first is given a

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# Structure of MADT Decision Tree
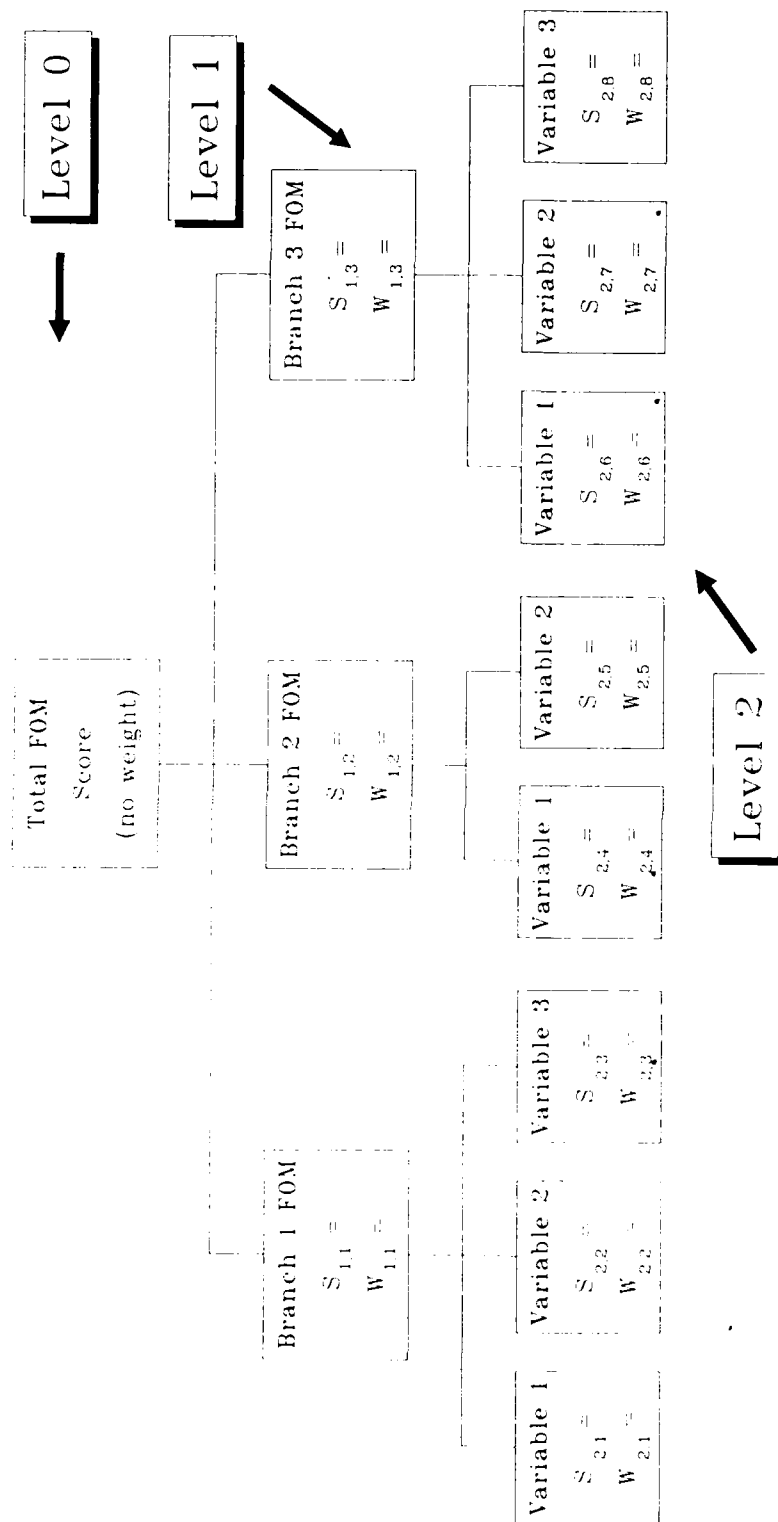


Figure D-1.   Structure of MADT Decision Tree.

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weight of two and the second a weight of one. This comparison is done only relative to related variables within a given level, which are grouped together as shown in Figure D-1. Weights cannot be used directly to compare the importance of variables in different groups. Some simple arithmetic would be required.

Next, in a top-down manner, these goals can be further decomposed into their own weighted subordinate contributors, which are at Level 2. This step is then repeated until, in each individual branch of the decision tree, the desired degree of detail is reached. The very nature of this process suggests the use of a decision tree structure. It should be noted that all of the input factor branches of this structure need not extend to the same lowest level of detail. As lower and more detailed levels are reached, the fine-structuring requires the attention of specialists from the available community-of-experts. At these lower levels of the decision tree analysis is provided of the component factors and uncertainty in them. Thus, the specific knowledge from these specialists can be combined and consolidated into the decision analysis procedure.

At these lowest levels, score values can be input or derived for each factor, based on either detailed analysis or knowledgeable opinion, and documented. As previously noted, some factors at these lowest levels may be influenced by (or dependent upon) other input factor values.

All higher level items (i.e., those above the lowest level (highest numerical level) of each branch of the decision tree) are evaluated by deriving their score from their lower level contributors. This scoring, done in a rote manner by the OPTIM code, utilizes the sum of the weighted scores of the contributors in the lower level group. For example, the score for the jth item at level L in the tree is computed as follows:

$$S_{L,j} = \frac{\sum_i W_{L+1,i} \, S_{L-1,i}}{\sum_i W_{L+1,i}} \quad , \quad (2)$$

where:

$S_{L,j}$ = the computed score for the jth item at level L, which is itself used to compute scores for items at level L-1;

$S_{L+1,i}$ = the previously computed score for the jth item at level L+1 which contributes to $S_{L,j}$ (note that the index i includes only those items within the group connected to the higher level item being calculated);

$W_{L+1,i}$ = the weight assigned to the ith item at level L+1.

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There are five distinct item types at the lowest level
of each individual branch of the decision tree for which
various input parameters are needed.  These inputs are used
to calculate the item's MADT score on a scale of 0 to 100.

    a)    Independent items have no other items as
contributors.  They are usually characterized by
having a particular scoring algorithm which can
be a straight line or other type of graph, or a set
of distinct score values for certain specified
problem or environment conditions.  For a particular
input value, a specific item score results.

    b)    Pre-scored items also have no other items as
contributors.  However, rather than having a graph
or algorithm, their score values are directly input.
As an example, say that a decision-maker's preference
structure for a particular policy might be:

        1.    approves---------------score of 100

        2.    is indifferent--------score of  50

        3.    disapproves-----------score of   0

The input for this type of item is then merely the score
derived from the list.

Another type of pre-scored item may be characterized as
a "shopping list."  Several entries can be listed, and the

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input score is then simply the total of the individual scores of any entries selected from the list.

1.     100 MX in silo --------score of 30

2.     300 SICBM--------------score of 40

3.      50 rail MX-----------score of 50

If 1. and 3. are chosen, the input score is (50 + 30) or 80.

c)     Dependent items are items whose score is solely dependent on the scores of other items.  There are two types of dependent items:

First order dependent items receive weighted contributions only from independent and pre-scored items.

Second (and higher) order dependent items receive weighted contributions from first order dependent items and/or other second order dependent items.

d)     Self-dependent items are a combination of the independent and dependent items, in that they have their own particular scoring algorithm (like an independent item) and also have other items that contribute (in a weighted manner)

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to their score.  The scoring of these self-
dependent items is similar to that for dependent
items.

e)   <u>Inner-dependent</u> <u>items</u> are items which can only
be scored <u>after</u> all other items are scored,
since they depend on the scores obtained at
other levels in the decision tree, (or on
the results obtained from other branches of
the decision tree.

In summary, the basis of multiple decision attribute
theory (MADT) is the decomposition of a complex problem into
a structured format whereby the many contributing factors to
the top-level problem evaluation can be individually
evaluated and then combined in a rational manner.  Indeed,
the detailing of the interactions between low-level factors
provides insight into the problem and a useful means for
simulation of the "real world."

Once structured, the problem can be evaluated for
various alternative courses-of-action, using appropriate
alternative values for the identified lowest-level input
factors.  All of the item-to-item dependent interactions are
then evaluated.  A figure of merit for each alternative
course-of-action can then be found at the top-most level by
evaluating and combining the weighted sums of the items at
each succeeding level.  A relative ranking of the alternative

courses-of-action can then be made, based upon their figures of merit. As results are obtained for the FOMs of the various courses-of-action, the input values can be adjusted and the calculations reiterated to find a more optimal FOM.

The structure of the decision tree itself can be modified, if necessary, either by "pruning" away factors that prove to have little effect on the overall figure of merit or by adding further detail to the tree. The weights associated with any factors at any level can also be "adjusted," as required, to obtain a more appropriate result for the decision-maker. Sensitivity analysis can be performed for specified parameters, as well as "what if?" excursions for selected individual parameters or groups of parameters.


D.3 COMPUTER PROGRAM.

A LOTUS 1-2-3 program was developed to facilitate use of the MADT decision tree. This menu driven program allows the user to select from five options, which range from simply viewing the tree structure on the computer screen to automating tree evaluation for a range of inputs and graphing the results. Each main menu option is listed and described in detail below. Once an option is chosen and executed, Control reverts to the main menu so that additional options may be discussed. Each of the options in the program's main menu is discussed separately below: View, Change, Group Input, Print, and View.

D.3.1 View.

By selecting this option the user can easily scroll through the different levels of the decision tree. After selecting the view option, a directional menu appears, allowing the cursor to be moved right or left, one tree level at a time, or up or down, one tree item within a given level at a time. Scrolling through the decision tree in this fashion, to view current items' scores or weights, is quick because the cursor is programed to skip over blank spaces between items and levels.

D.3.2 Change.

After selecting this option the user is presented with a modified version of the directional menu that appeared under the View option. Two additional functions are incorporated into the menu, they are Change and Window. Once the user has positioned the cursor (using the Right, Left, Up Down options) to the desired tree item, selecting Change allows that item's weight to be changed, or if the designated item is on the last level, its score can be changed a so. Changing any item's weight or score could possib y effect all connecting groups at lower numbered levels, although small changes in high numbered levels are often undetected in lower numbered levels because of the weighted average scoring algorithm used to evaluate the tree. However, since the user may wish to monitor the score of a particular item while he changes the weight or score for another item in a different

level of the tree, the Window option is available. By
selecting this option, the user selects an item he wishes to
lock onto the computer screen. This item is put into a
"window," or one portion of the screen, while the other
portion of the screen is used to scroll through the tree.
(See Figure D-2.) If the Change option is then selected for
some other item in the tree, the user can monitor how
variations in the item's weight or score will effect the
windowed item.

D.3.3  Group Input.

This option prepares a particular branch of the decision
tree for input of weights and/or scores. Consecutive menus
appear after selecting the Group Input option to determine
which branch of the tree the user desires to be made
available for input. For example, the first menu would be to
select between the Political, Economic, and Military FOM
branches. If the user were to select the Political branch, a
second menu would allow input for the entire Political branch
or for either the Domestic Politics or Foreign Policy branch.
This option proves useful when a new scenario is to be
evaluated and different weights and/or scores are necessary
to depict the new environment. Group Input is a faster means
for making these changes than the Change option.

Menu used to perform various
operations. See text for a
user's manual.

```
CU666: [W4] 'Great Britain                                                    [MENU]
[Right]  Left  Up  Down  Change  Window  Algorithm  Quit
Move right 1 level
     CK    CL    CM    CN       CO   CP   CQ    CR    CS   CT  CU    CV    CW    CX   CY
673│                        │666│                         │-- Great Britain          Inpu
674│                        │667│                         │     W=     2  S=    80    4
675│                        │668│                         │
676│                        │669│                         │-- West Germany           Inpu
677│                        │670│                         │     W=     2  S=    80    4
678│                        │671│                         │
679│                        │672│                         │-- France                 Inpu
680│ Foreign Policy         │673│ -- U.S. Allies          │     W=     2  S=    60    3
681│   W=     1  S= 80.56   │674│     W=     4  S= 76.43   │
682│                        │675│                         │-- Other NATO             Inpu
683│                        │676│                         │     W=    0.2  S=   60    3
684│                        │677│                         │
685│                        │673│                         │-- Japan                  Inpu
686│                        │679│                         │     W=     1  S=   100   5
687│                        │680│                         │
688│                        │681│                         │-- Other Non-NATO         Inpu
689│                        │682│                         │     W=    0.1  S=   60    3
690│                        │683│                         │
691│                        │684│ -- Soviet Union     Input
692│                        │685│  · W=     2  S=   100  5
26-Feb-87   04:50 PM                              CMD
```

Two windows are used to view different
parts of the tree simultaneously.

Figure D-2.    Example of computer screen during
               execution of MADT program.

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D.3.4 Print.

The Print option produces on paper a copy of the
decision tree with its current weights and scores. Figure
D-3 shows a sample output.

D.3.5 What If.

Using a decision tree such as that in Figure D-3, the
What If option is designed to answer such questions as: If
the weight for Public Opinion were to vary from 0 to 10, how
would this effect Domestic Politics, the Political FOM, and
the overall FOM? What If the score for Strategic BMD is not
known exactly, but is believed to be between 70 and 90; how
does this range of scores influence Defensive Forces, the
Military FOM, and the overall FOM? What If the scores for
Public Opinion, U.S. Allies and Soviet Union, were to
represent four different possible future environments, which
would be the most beneficial for Foreign Policy, Domestic
Politics, the Political FOM, and the overall FOM?

There are two types of questions being asked here, the
first asks what happens to the tree when a single item is
evaluated for a range of either weights or scores, and the
second asks what happens to the tree when a group of items
have their weights or scores changed in an attempt to
describe various scenarios. In either case, the user selects
the single item or identifies the group of items he wishes to
use to measure the sensitivity of certain other tree items.
If the selected item or items are from the last level of the

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```
                                                              !-- Public Opinion
                                                              !    W=    1  S=    50
                                              !- Domestic Politics  !-- Congress
                                              !    W=    1  S=   50 !    W=    2  S=   50
          !-- Political FOM                   !                     !
          !    W=    1  S=   50               !                     !-- Executive Politics
          !                                   !                          W=    2  S=   50
          !                                   !
          !                                   !                     !-- U.S. Allies
          !                                   !                     !    W=    4  S=   50
          !                                   !                     !
          !                                   !-- Foreign Policy    !-- Soviet Union
          !                                   !    W=    1  S=   50  !    W=    2  S=   50
          !                                                         !
          !                                                         !-- China
          !                                                         !    W=   0.5 S=   50
          !                                                         !
          !                                                         !-- World Opinion
          !                                                              W=   0.1 S=   50

                                                                   !-- SDI
                                                                   !    W=    1  S=   50
                                              !-- Direct Costs     !-- Midgetman
                                              !    W=    2  S=   50 !    W=    0  S=   50
                                              !                    !
                                              !                    !-- MX Rail Mobile
                                              !                         W=    0  S=   50

                                                                   !-- SDI
                                                                   !    W=    1  S=   50
Total FOM       !- Economic FOM    !- Indirect Costs    !- Midgetman
 S=    50       !    W=    1  S=   50 !    W=    1  S=   50  W=    0  S=   50
                !                    !
                !                    !                    !-- MX/Rail Mobile
                !                    !                         W=    0  S=   50
                !                    !
                !                    !                    !-- DOD Budget
                !                    !-- Overall Budget   !    W=    1  S=   50
                !                         W=    1  S=   50 !
                !                                          !-- Federal Budget
                !                                               W=    1  S=   50

                                                          !-- Air Defense
                                                          !    W=   0.5 S=   50
                                      !-- Defensive Forces  !-- Theater BMD
                                      !    W=    1  S=   50  !    W=    1  S=   50
                                      !                    !
                                      !                    !-- Strategic BMD
                                      !                         W=    1  S=   50
         !-- Military FOM             !
         !    W=    1  S=   50         !                    !-- Triad
                                      !                    !    W=    1  S=   50
                                      !                    !
                                      !                    !-- ICBM
                                      !-- Offensive Forces !    W=    1  S=   50
                                           W=    1  S=   50 !
                                                           !-- SLBM
                                                           !    W=    1  S=   50
                                                           !
                                                           !-- Bomber
                                                                W=   0.5 S=   50
```
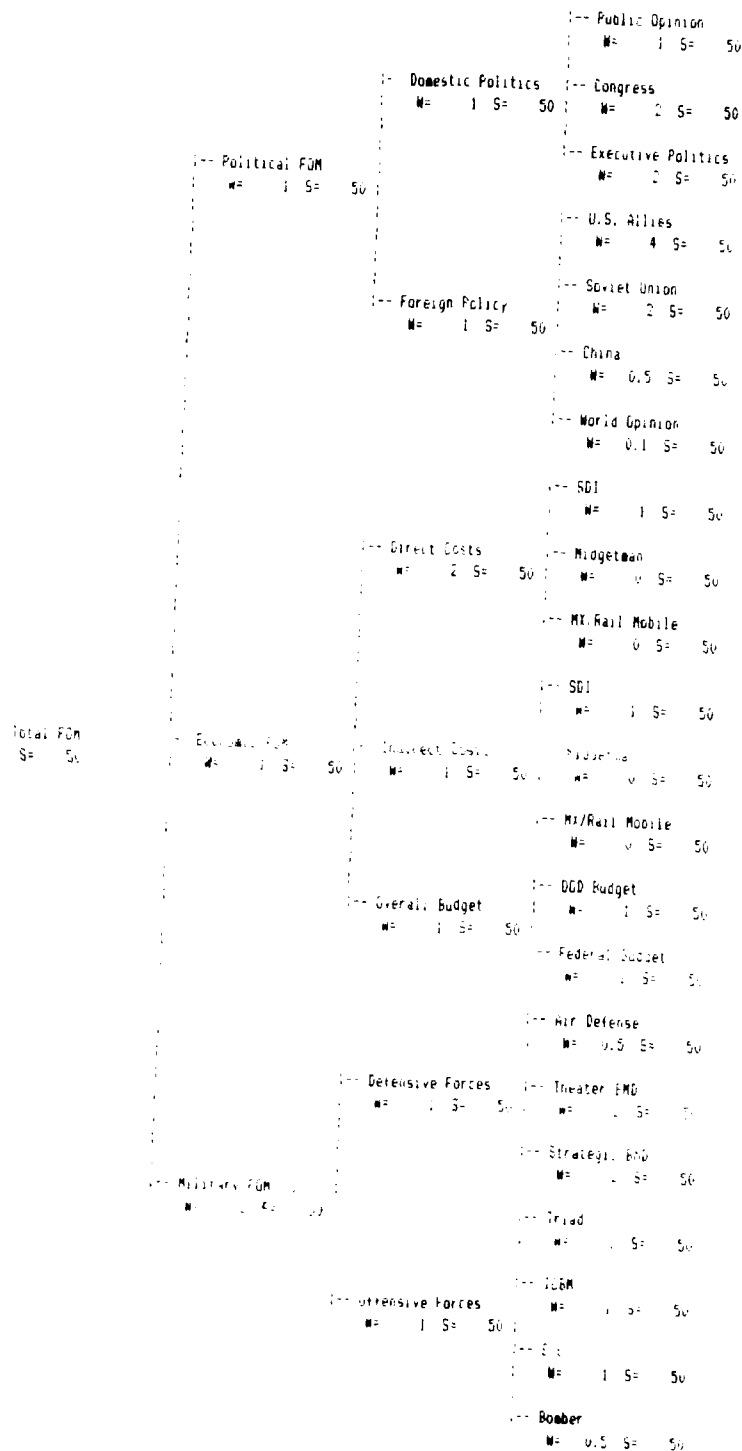
Figure D-3. Decision Tree Structure.

tree the user must specify whether weight or score is to be the manipulating factor, otherwise only weights for non-last level items can be changed.

For single item sensitivity measuring, the user defines the initial value, final value, and incremental value for the range of weights or scores. Multiple item sensitivity measuring requires the user to provide the specific weight or score for each of the selected items, for each scenario being evaluated.

Both What If questions allow the user to select those tree items whose sensitivity is to be measured and graphed. The overall FOM will automatically be recorded and graphed for both types of What If questions. The graphs of Figures D-4 through D-6 were created under the What If option and illustrate the possible ways of utilizing this option as well as its usefulness in graphically displaying the tree's sensitivity to certain factors. Table D-1 lists the input scores for the options illustrated in Figure D-6.

D.3.6 Assessment.

Careful analysis which included several in-house mini-games conducted at HRA, Inc. indicated that, while MADT is potentially a valuable tool, it also has several serious drawbacks when used in a mini-game format. First, a mini-game places severe time-constraints on the use of MADT programs. Even though the actual data entry, computations, and production of graphical or tabular output can be done
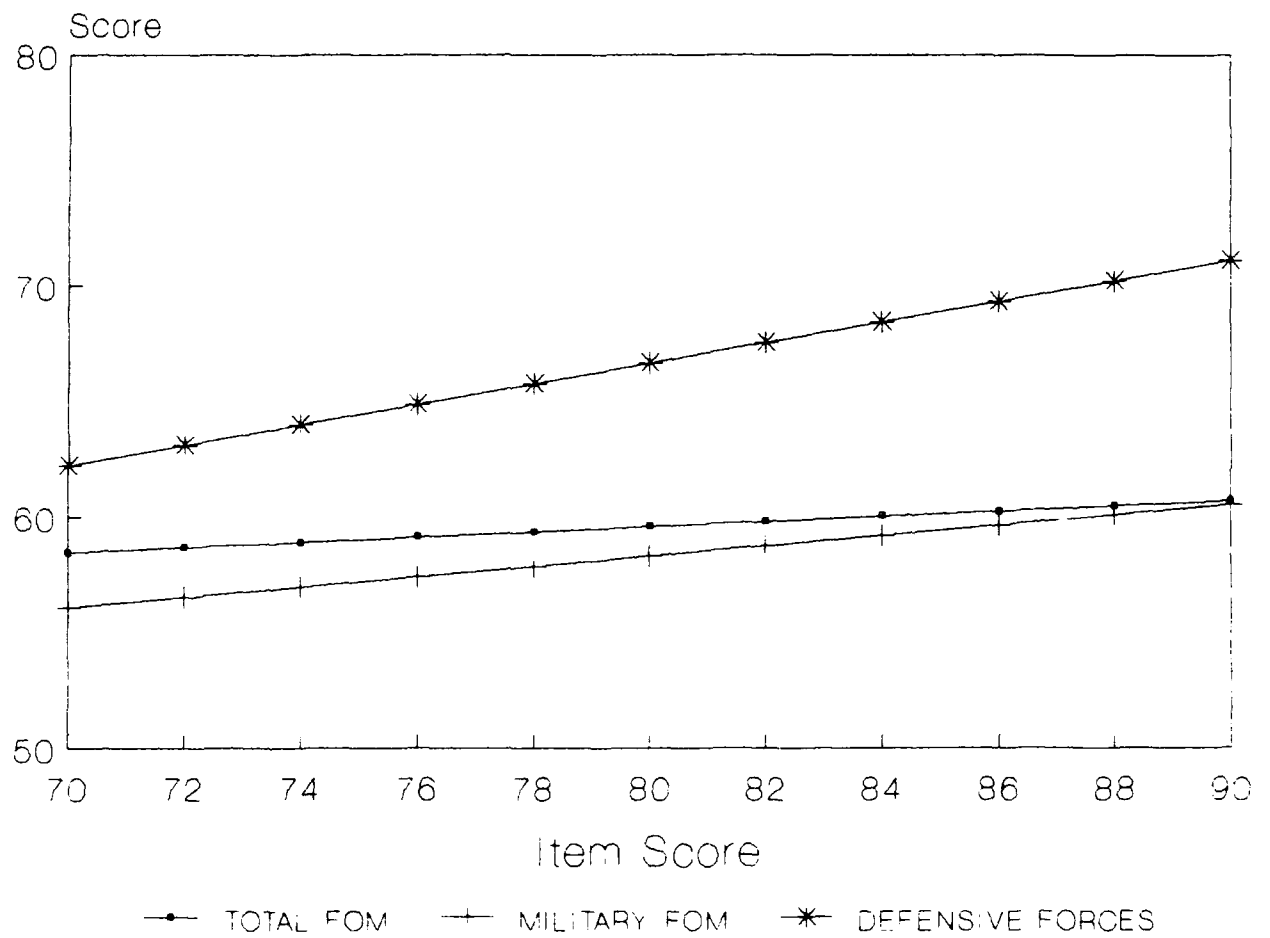
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# Strategic BMD



Figure D-4. Sensitivity of Range of Weight for Single item.
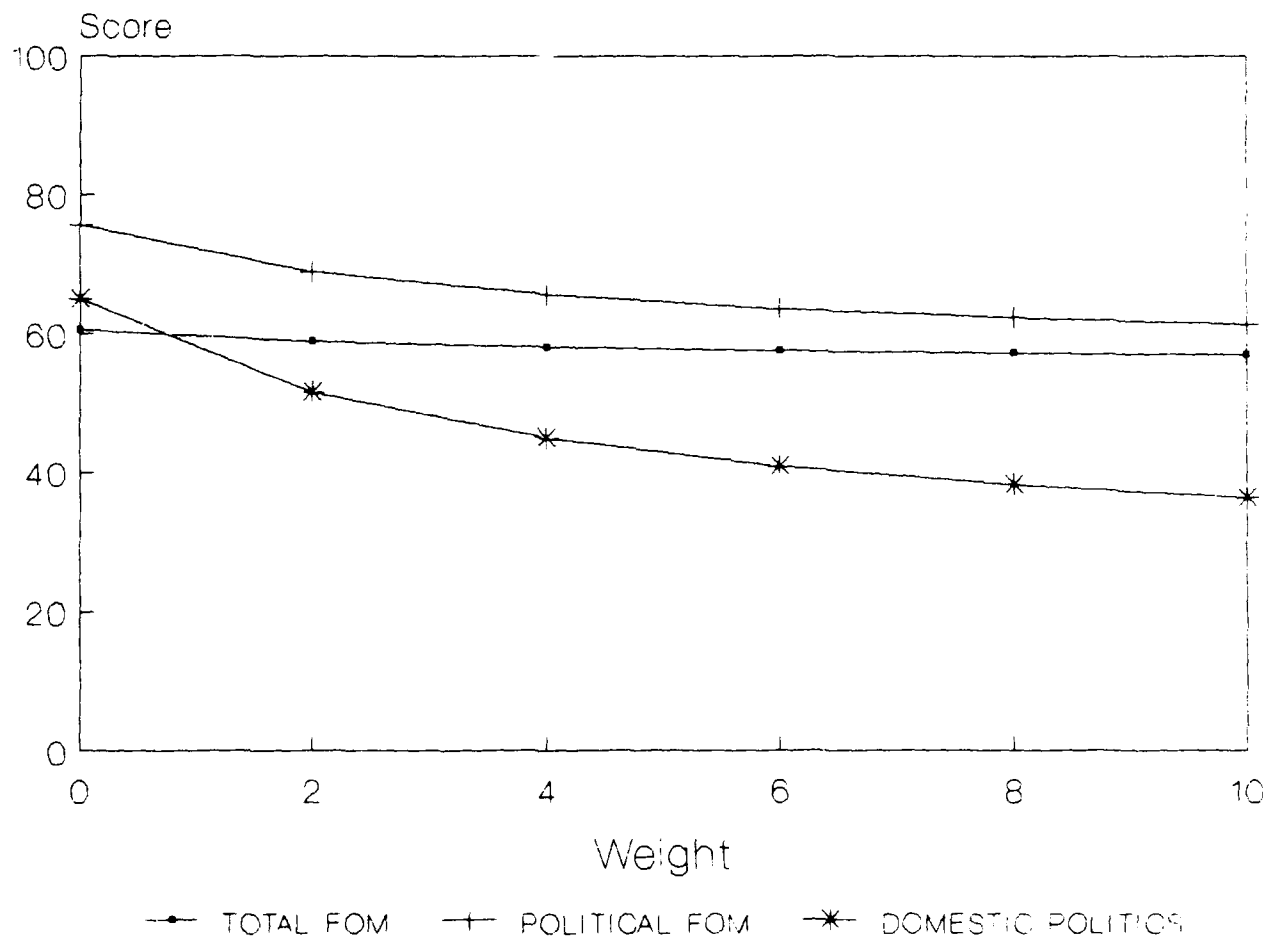
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# Public Opinion



Figure D-5.  Sensitivity to Range of Score for Single Item.

## Score as a function of
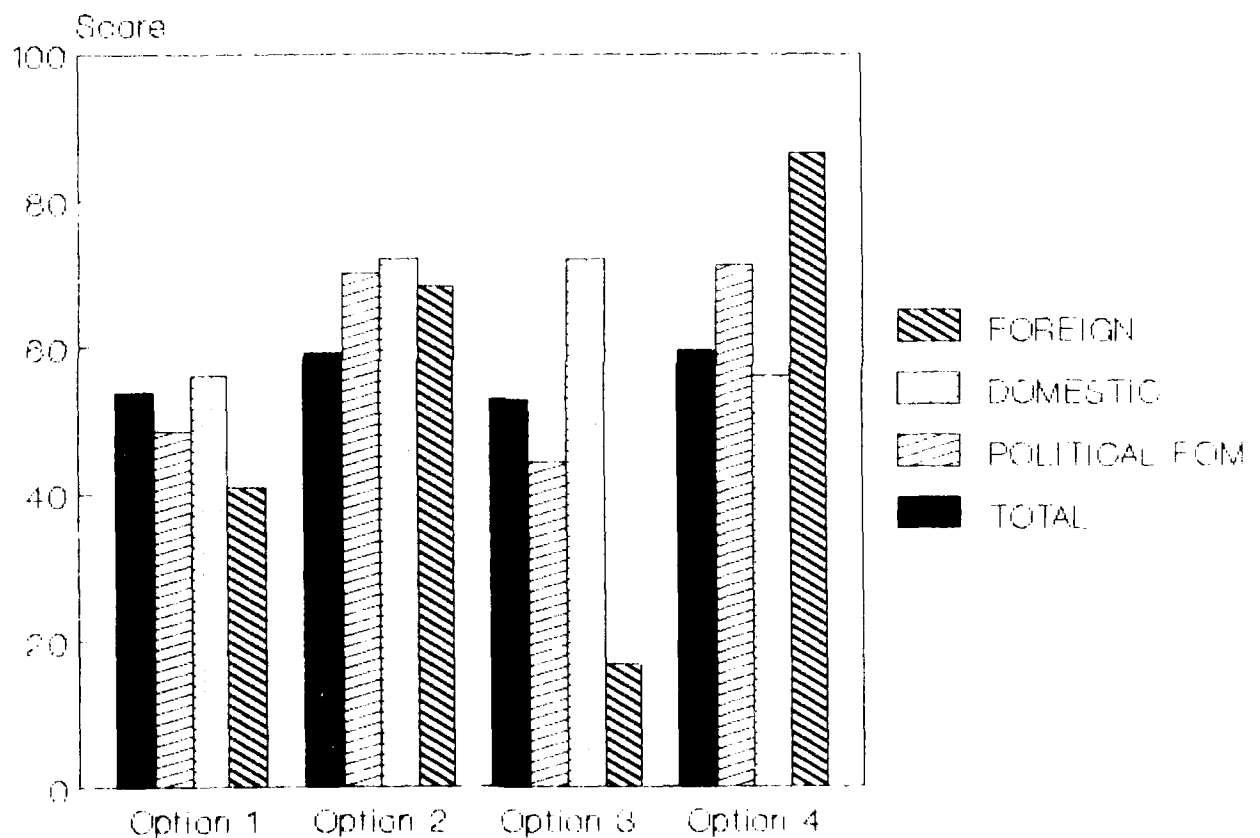## Public Opinion, US Allies, Soviet Union



Figure D-6. Multiple Item Alterations Representing Different Scenarios.

Table D-1. Item Input Scores For Options
Illustrated In Figure E-6.

|  | Option 1 | Option 2 | Option 3 | Option 4 |
|---|---|---|---|---|
| Public Opinion | 20 | 100 | 100 | 20 |
| U.S. Allies | 15 | 100 | 15 | 90 |
| Soviet Union | 90 | 10 | 10 | 90 |

quickly, the determination of the input values for all of the items at the lowest level in the tree is a time-consuming process. Many trees require as many as 100 inputs. These trees can be simplified by "pruning" the branches at the lower levels, but some details must remain for the decision tree to be non-trivial. In fact, in-house gaming determined that even the smaller trees that retained some non-trivial structure were too cumbersome to be easily accommodated into the mini-game format.

Second, the use of MADT can easily distract the players' attention toward the details of either the scoring algorithms or the assessment of input values and away from the main issues of the game itself. Finally the MADT format is too complex to be easily understood and used by players unfamiliar with its methodology. Consequently, this particular application of MADT was not implemented.

On the other hand, MADT proved to be more useful in analyzing the results from mini-games in order to interpret them and provide useful insights for future path games. These programs can especially help the game developers in formulating topics for games in a series of mini-games.

The other formats, since they relax the time constraints of the mini-game formats, can use the MADT programs better. However, only extended games have sufficient time for the control team to utilize these decision aids effectively.

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